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Making Boiler Sections on Molding Machines

Specialized Practice of the H. B. Smith Co., Westfield, Mass., Which Effects Great Economies

By E C Kreutzberg

AMONG the factors which have contributed to the great progress in the art of molding during the past few years, none, perhaps, is more worthy of note than the extensive development of the joint use of stripping plate and jar ramming methods. The manifold advantages of this modern practice, in producing castings of which unlimited numbers are required, have become apparent to foundrymen all over the country, who have not hesitated to undergo heavy expense in making the necessary changes in equipment. Particularly have stripping plate methods, in conjunction with the use of the jolter, proved successful in large specialty shops, and as a result some very interesting and highly efficient apparatus has come into being. The self-imposed task of the managers of such plants has been to develop riggings especially adapted to certain patterns, and which would admit of the highest possible output together with the least possible amount of molding effort. A shop which reflects in very high degree this modern tendency toward specialization is the boiler plant of the H. B. Smith Co., Westfield, Mass. This plant is devoted exclusively to the casting of iron boilers, both sectional and round, the output of which aggregates some 75 tons daily. The equipment at the Smith company's plant is of especial interest, since the methods in use effectively dispel the old prejudice that the jar-ramming machine cannot be employed successfully in making shell castings.

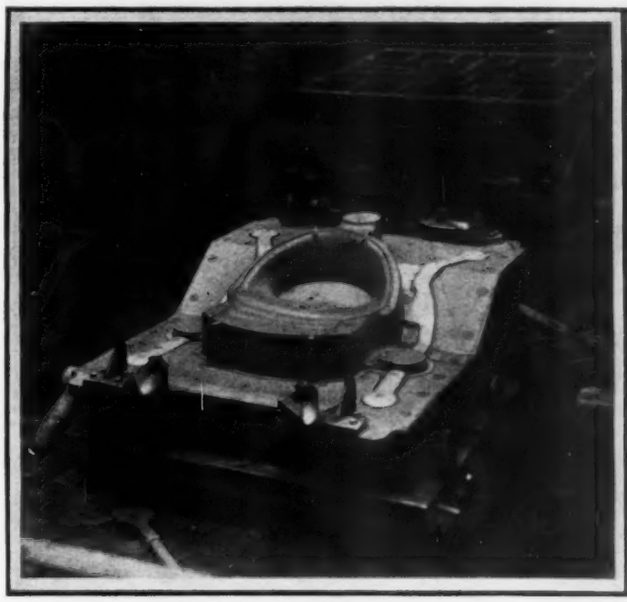

FIG. 1—HAND STRIPPING MACHINE FOR MAKING COPE OF ROUND BOILER FIRE POT MOLD

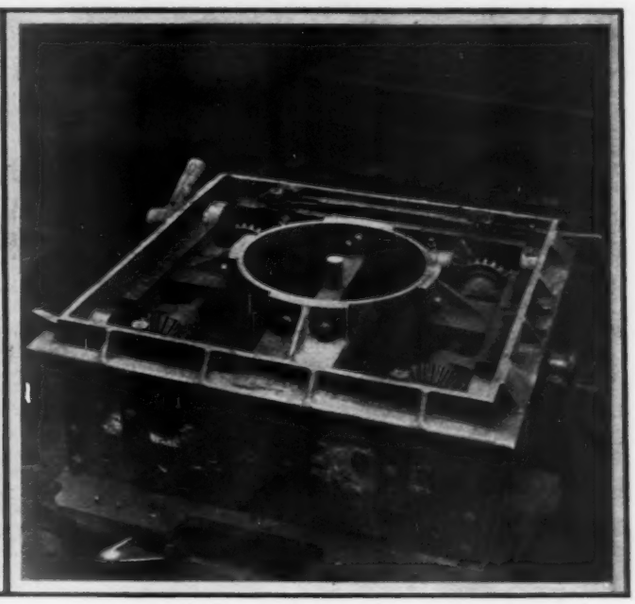

FIG. 2—BASE OF COPE MACHINE, SHOWING GEAR MECHANISM FOR ACTUATING CAM STRIPPING DEVICE

Round boilers originally were made at the Smith foundry by means of deep pit molding machines on which the molds were rammed by hand. In these machines the pattern was drawn through the stripping plate into the pit by means of a geared screw. By the new method, hand ramming is eliminated entirely by the use of the jolter, and each half of each pattern is mounted upon a portable, specially constructed, stripping plate machine, in which the stripping is accomplished in one of three ways: By the use of the crane, by the stripping attachment on the jolter, or by means of a hand-operated, cam-stripping device in the machine itself.

Typical cope and drag machines in which the stripping is accomplished by means of cams, are shown in Figs. 1, 2 and 3. These machines are of the flask lifting type and consist of the pattern, stripping plate and base. The stripping device, for lifting the mold off the pattern, consists of four cams, one at each corner of the machine, which are mounted on shafts, placed at right angles to each other, and which mesh by means of mitre gears. These shafts, controlled by means of a lever, impart their motion to four cams, causing them to elevate or lower the stripping plate

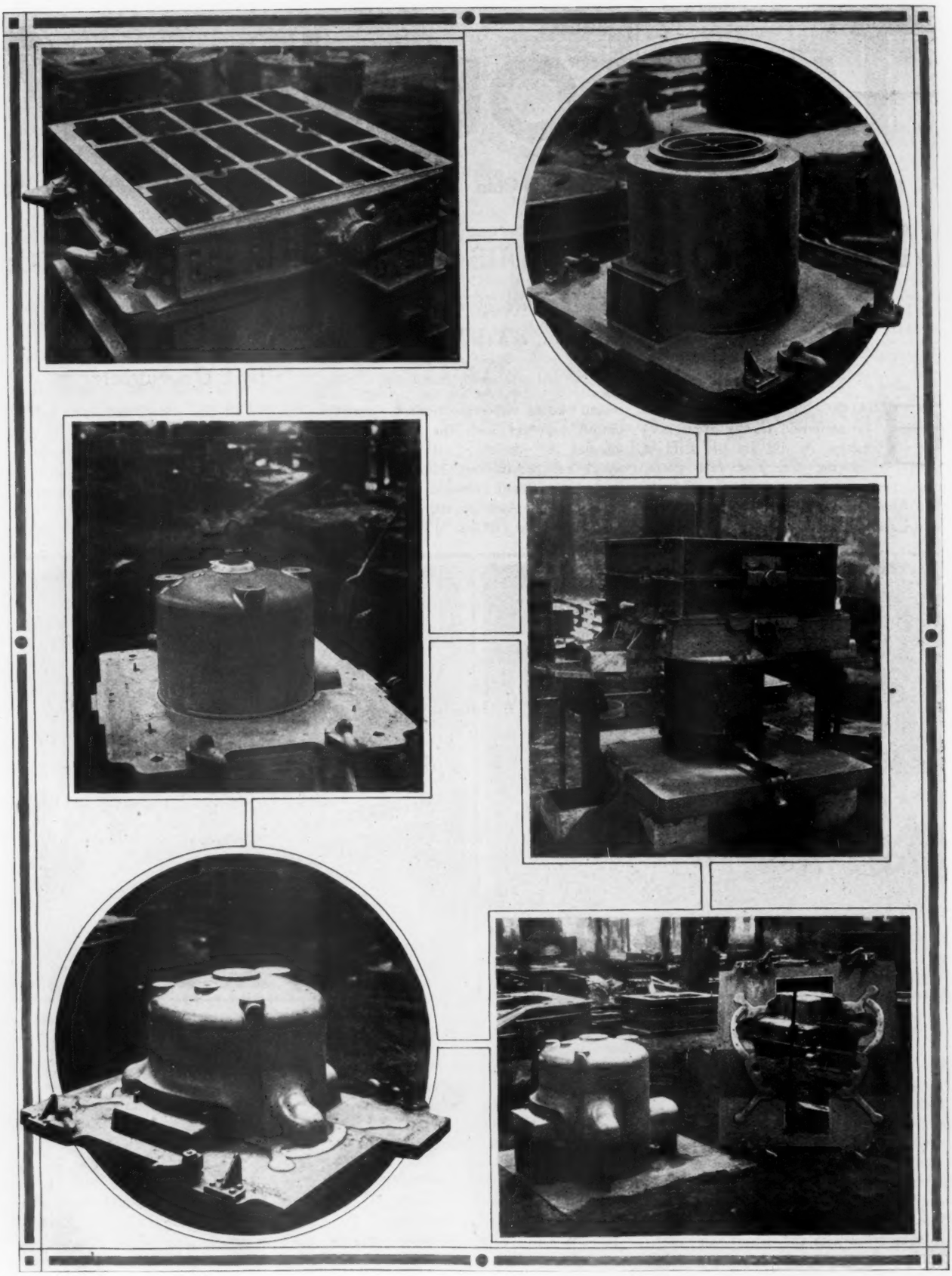

FIG. 3—DRAG MACHINE FOR ROUND BOILER FIRE POT MOLD, WITH FLASK

FIG. 4—CRANE STRIPPING MACHINE FOR MAKING DRAG FOR ANOTHER TYPE OF ROUND BOILER MOLD

FIG. 5—COPE MACHINE, FOR MAKING CHEEK AND COVERING COPE

FIG. 6—SHOWING USE OF JOLTER STRIPPING MECHANISM IN RAISING STRIPPING PLATE—VIEW SHOWS CHEEK ONLY, COPE HAVING BEEN REMOVED

FIG. 7—MACHINE FOR MAKING DRAG FOR DOME SECTION OF ANOTHER TYPE OF ROUND BOILER

FIG. 8—DRAG MACHINE, SHOWING STRIPPING PLATE REMOVED FROM PATTERN

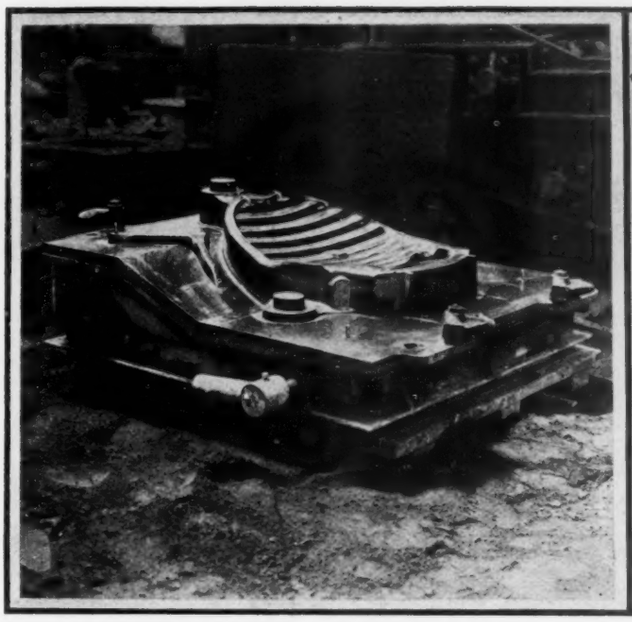

FIG. 9—MACHINE FOR MAKING COPE PORTION OF ROUND BOILER DOME MOLD

FIG. 10—COPE MACHINE, SHOWING METHOD OF STRIPPING MOLD OFF PATTERN BY HAND-OPERATED CAMS

as desired. The shafts are provided with a locking device, as well as with an adjustment for insuring the uniform movement of the cams. The construction of the cam stripping device is illustrated clearly in Fig. 2, which shows the base of the cope machine. With these machines, the cope and drag sections of the mold are made in exactly the same manner. The flask is secured to the machine by means of rotary cam clamps on the stripping plate, sand is shoveled into the flask, and flask and machine then are transported to the jolter, where the mold is rammed. The machine, together with the mold, then is transferred back to the floor. Here the stripping plate is raised by means of the hand-operated cam device, the flask is unclamped and the mold lifted off the machine and set on the floor. The stripping plate then is lowered, after which another flask may be set on. Fig. 1 shows the top of the cope machine, while Fig. 3 shows the drag machine, provided with flask.

A somewhat more complicated rigging and molding process is that required for another type of round boiler, the molding machines for which are shown in Figs. 4, 5 and 6. The drag machine, as shown in Fig. 4, consists of pattern and stripping plate, and is provided with a wood jolting base. The flask first is clamped on the stripping plate, after which sand is shoveled into the flask, and the unit taken to the jolter, where the mold is rammed. On being carried back to the floor, the mold is rolled over, the pattern drawn out through the stripping plate and the stripping plate removed. The cope machine, shown in Fig. 5, is employed for molding the cheek and the covering cope, this being a three-part mold. The cheek first is rammed on the jolter, after which the cope is rammed by hand. The entire unit then is carried to the jolter, where the pattern is clamped to the jolting table while the stripping plate, carrying the cheek and cope, is elevated by means of the stripping attachment on the jolter. First the cope is removed, leaving the mold in the position shown in Fig. 6. The cheek next is removed, the weight of the sand being sustained by a circular steel flange in the base of the cheek. After this, the molding machine is reassembled by lowering the stripping plate to its original position

FIG. 11—ROUND BOILER DOME MOLDS IN VARIOUS STAGES OF COMPLETION

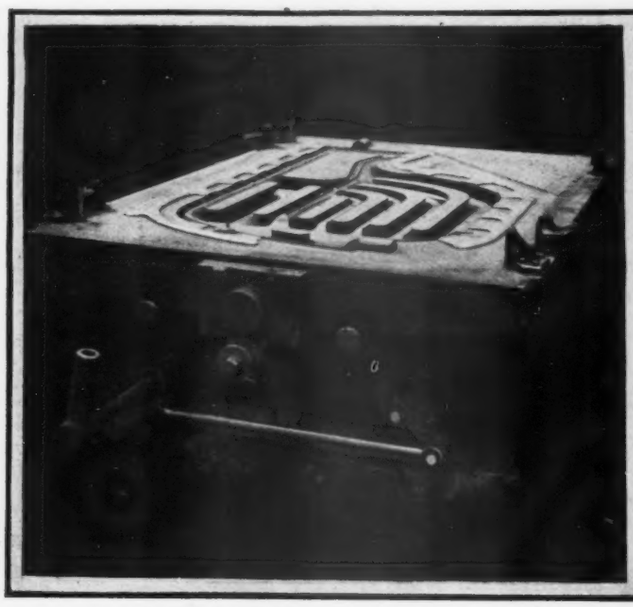

FIG. 12 — SECTIONAL BOILER DRAG MOLDING MACHINE, SHOWING PATTERN DROPPED

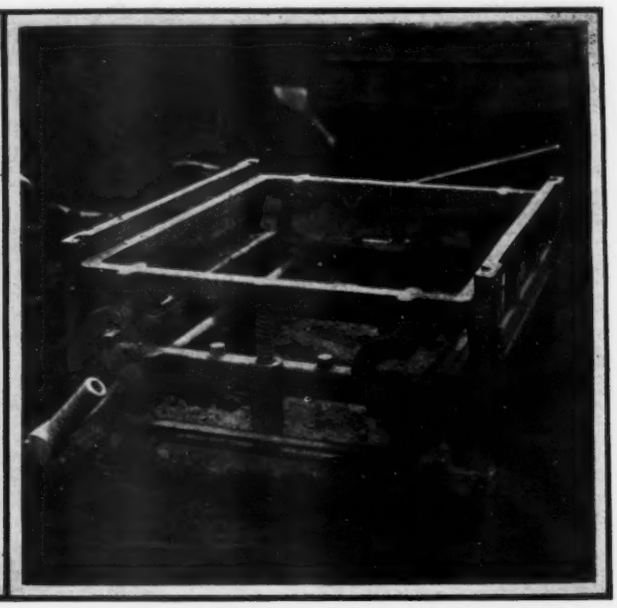

FIG. 13—CONSTRUCTION OF BASE OF DRAG MACHINE

around the base of the pattern. The necessity for stripping this mold in this fashion arises from the inability of the cheek successfully to withstand the strain of a roll-over.

A slight variation of the preceding practice is found in molding the dome portion of another type of round boiler. The cope and drag machines for this job are illustrated in Figs. 7, 8, 9 and 10. In this case, the drag is rammed on the jolter, after which the mold is rolled over on the floor and the pattern drawn through the stripping plate. The stripping plate then is removed and put back in its original position around the base of the pattern. The machine, with stripping plate in both positions with reference to the pattern, is shown in Figs. 7 and 8. The cope is made on a hand-operated, cam-stripping machine which is operated in precisely the same fashion as the cam-stripping machines previously described. Figs. 9 and 10 show this machine with the stripping plate both in the elevated and in the normal position.

All of the molding operations in connection with the casting of round boilers are carried on with the aid of cranes, and to facilitate the work all machines and flasks are provided with trunnions. The molding machines, with the exception, in some cases, of a wood jolting base, are constructed entirely of iron and steel. Fig. 2 shows the customary method of providing supports which will enable the pattern plate to sustain the shocks incidental to jar-ramming. The flasks also are of very substantial construction, as indicated in Fig. 11, which shows the molds produced on the machines shown in Figs. 7 and 9. This type of equipment has been extended to the full line of round boilers manufactured by the H. B. Smith Co., embracing 16 different styles and sizes.

The experience at the Smith company's plant bears out the contention that the jolting machine has great capacity for work; its capacity, in fact, is limited only by the facility with which the work may be brought to and taken away from the machine. The location of the

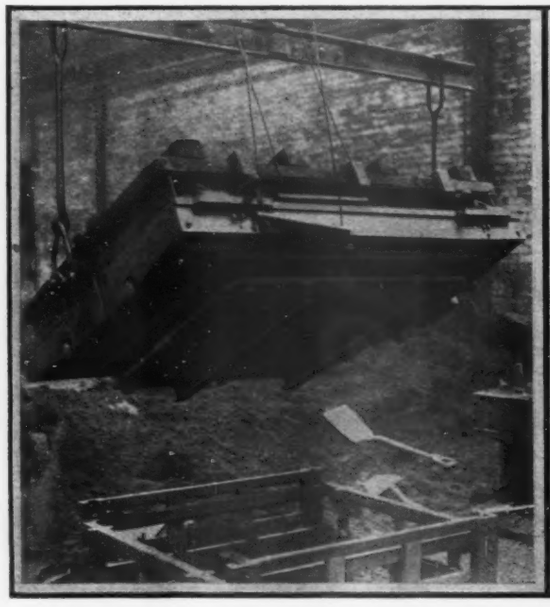

FIG. 14—DRAG AND STRIPPING PLATE, REMOVED FROM MACHINE AND READY TO BE ROLLED OVER

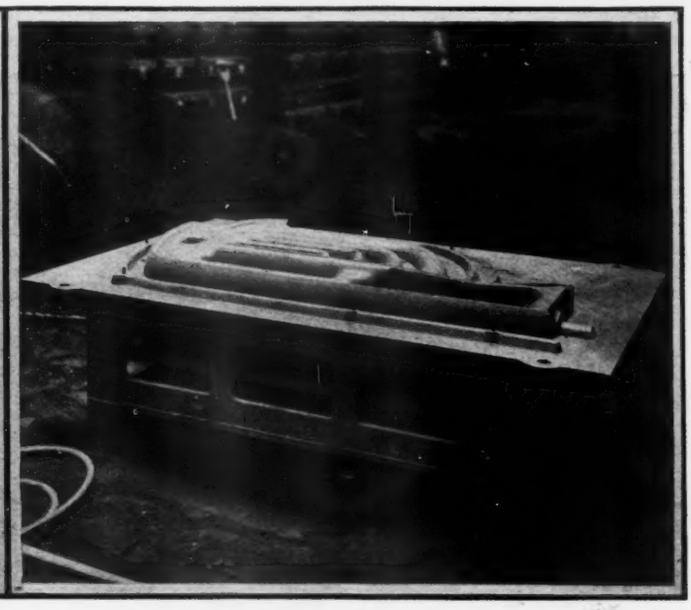

FIG. 15—COPE MACHINE, SHOWING PATTERN IN ELEVATED POSITION

jolter, therefore, and the means provided for transporting the work to and from the various floors, necessarily determine its efficiency, and this is a problem to be solved independently in each foundry. The best that can be done under any ordinary circumstances, however, is to keep the jolter busy only a part of the time. The Smith company has found it decidedly advantageous not to attach patterns to individual jolters, but to install the jolters so that they may be used in common by a number of floors. At present two 50 x 50-inch jolters are in use, one of which is electrically and the other pneumatically operated. A third, which now is being installed, will be in operation shortly; this is to be electrically driven. Of the two jolters now in operation, one is in the south center bay and the other in the north center bay; in these two bays are located all the round boiler molding floors. The south center bay is served by one five-ton, cab-operated, electric, traveling crane and two two-ton, floor-operated, electric, traveling cranes. The north center bay is served by two five-ton, cab-operated cranes and one two-ton floor-operated crane. Each of the bays is 25 feet wide, so that the cranes, with the exception of the five-ton, may be exchanged from one bay to another as they are required. In fact, facilities are such that a crane may be changed from one bay to another in the short space of 30 minutes. In addition, there is a four-ton jib crane between the two bays, which directly serves one of the two jolters, and which can be used in transferring molds from one to another, thus making it possible to use either jolter from any floor in the two center bays. With this extensive transportation service, the jolters are kept busy a maximum proportion of the time, and the molders very seldom experience any delay in having their molds transported to and from the machines.

Use of Stripping Plate Machines

Sectional boilers also are molded at the Smith plant by means of highly efficient stripping plate machines. Originally the patterns at this plant were mounted on regular Pridmore stripping plate machines. Later on these machines were rebuilt, some of the features being modified and certain parts strengthened; in general, however, they still are substantially of the Pridmore design. Figs. 12, 13, 14, 15 and 16 illustrate typical apparatus used in making sectional boiler molds. Cope and drag machines each are of the stripping plate, drop-pattern type. In the cope, the mold is lifted off the machine independently, while in the drag the stripping plate is lifted off with the mold for the roll-over. Fig. 13 shows base of the drag machine with stripping plate removed, while Fig. 14 shows the base with mold and stripping plate suspended above it. Fig. 12 shows the machine complete, with pattern dropped, while Fig. 15 shows the cope machine with pattern raised. The output by means of the equipment shown in Figs. 12 and 15 is 30 molds per day. On this job, two men are required on the cope machine, two on the drag machine, while one man and a helper set cores and finish the molds. In the case of the very large sectional boiler patterns, the machines are placed on masonry foundations, over pits which are provided for the purpose of rendering the base of the machine accessible in case of necessary repairs. Fig. 16, an illustration of a sectional boiler molding floor, shows the character of the flasks used in this work. These are constructed of steel channels. The illustration shows how sand is economized by cutting off corners by means of internal strips; by this method the advantages of having a rectangular shaped flask are retained.

FIG. 16—FLOOR OF SECTIONAL BOILER MOLDS, SHOWING CONSTRUCTION OF FLASKS

The two side bays of the foundry, each 25 feet wide and 245 feet long, are devoted entirely to the making of sectional boiler molds. All of the handling is done with the aid of cranes and to facilitate the work all the machines and flasks are provided with trunnions. Each bay contains three two-ton, floor-operated traveling cranes; these can be interchanged from one bay to another as needed. In addition there is a spare crane of the same capacity. For handling the very large sectional boiler molds there is a four-ton bridge crane.

For making boiler drums and the lighter sections, Pridmore stripping plate machines are employed entirely. In addition, a great many Pridmore machines

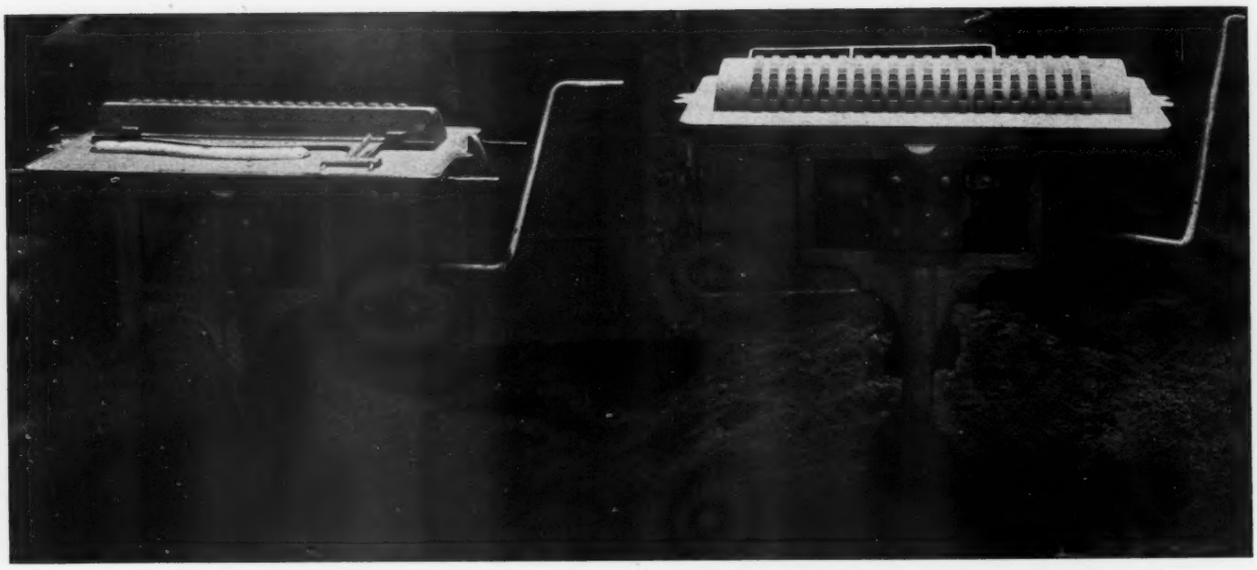

FIG. 17—STRIPPING PLATE MACHINES USED FOR MAKING BOILER GRATE MOLDS

are used for making boiler trimmings. Figs. 17 and 18 shows the method of making grate bar molds on stripping plate machines of this type. A Taylor pneumatic squeezer also is employed for making trimmings, an Arcade rollover is used for making furnace doors, while difficult grate castings are made by means of a Pridmore rockover. A great many small castings at this plant are made entirely in the drag, which usually is molded on a stripping plate machine; in such cases, "flat-backs", of the flask-lifting type, are used in making the copes.

Among the noteworthy features at this plant is the fact that of the burned sand which adheres to the castings and the core sand which is carried to the cleaning room, approximately 60 to 70 per cent is utilized by the core making department. Early attempts to use this sand for cores at this plant led to the conclusion that the factor of prime importance in securing satisfactory results is the removal of all dust. Accordingly a very interesting mechanical system has been devised for winnowing the burned sand. The sand, after it has been removed from the castings in the cleaning room, is collected in wheelbarrows and dumped into a pit, whence it is elevated, by means of a bucket chain, into a revolving cylinder, or drum, of which the receiving end is slightly higher than the discharge end. The interior of this drum is provided with a number of vanes, half of which are L-shaped and half straight, thus forming pockets from which the sand falls as the drum rotates. In addition, there extends through the drum a steel plate on which the sand falls, which causes it to be deflected and again spread out. Through slots in the shell of the drum, air currents are induced, which pass through the curtains of falling sand, effectually removing all dust and permitting the sand, after several revolutions, to fall from the discharge end of the drum into a hopper. The air, after having been induced through the drum, is passed through a Sly dust collector. From the hopper, the winnowed sand is discharged, as it is needed, into a bucket which travels on the tram-rail connecting with the core department. In the core department, this winnowed sand is used with new bank sand in varying portions, ranging from one to two to one to one, and in some cases more of the winnowed sand than new sand is used.

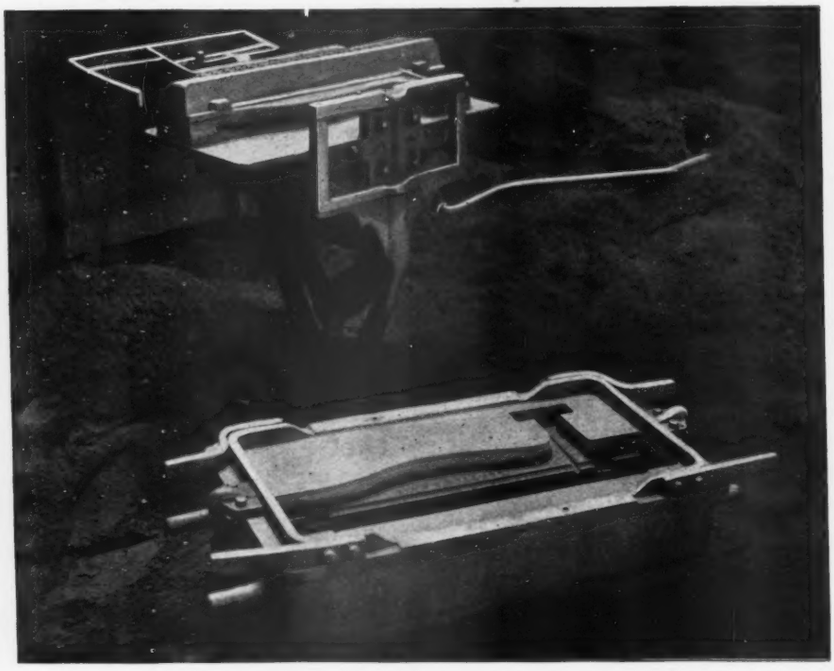

FIG. 18—DRAG SECTION OF GRATE BAR MOLD

The mixing department of the core room is another exceedingly interesting installation. The sand is mixed by shovel, in the proportions already noted, and dumped into a hopper, whence it is elevated, by means of a chain bucket, into the receiving end of a revolving screen. The screened sand passes into a hopper which feeds a measuring chute, while the tailings work themselves out of the discharge end of the screen, thence being carried away by means of a chute designed for this purpose. The measuring chute is an ingenious device which makes for absolute accuracy in controlling the core sand mixture. The chute is provided with two swinging blades or gates,

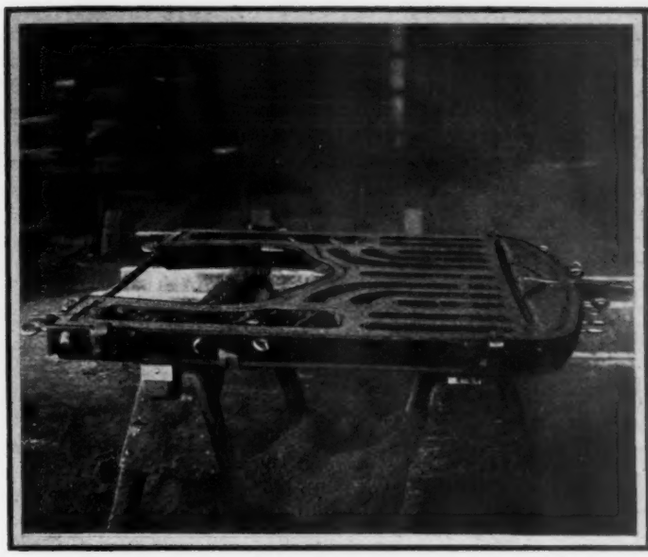

FIG. 19—ONE HALF OF BOOKING CORE BOX, SHOWING METHOD OF INSERTING VENT RODS

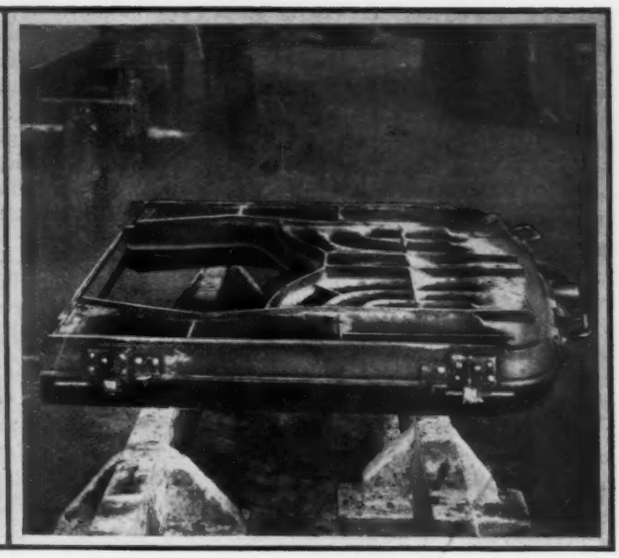

FIG. 20—COMPLETE CORE BOX, WITH VENT RODS REMOVED, AFTER BEING BOOKED ON THE BOOKING WAYS

which are so spaced as to measure off three cubic feet of sand. The bottom gate first is set and the sand permitted to flow down into the chute from the receiving hopper; after the sand has reached a sufficient depth, it is cut off by means of the top gate. The bottom gate then is withdrawn, permitting the measured sand to drop into an L. C. Smith concrete mixer below. Flour, in the proportion of one to 12 or 14 of sand, and water, then are added, these components being mixed thoroughly in the concrete mixer. From the concrete mixer the sand is passed through a paddle mixer and blending roll of the Standard Sand & Machine Co.'s type, after which it is discharged into a bin, to be removed as the coremakers require it. From 16 to 20 tons of sand are consumed daily by the core department.

Cast Iron Core Boxes

Figs. 19 and 20 show the type of core box now used almost exclusively by this company for making sectional boiler cores. This box is of cast iron and is of the booking type. Each half is rammed separately and is then taken to the booking ways, where the two halves are booked together. One half of the box then is removed, while the other half, with the core, then is ready to be charged into the oven. As shown in Fig. 19, the cores are vented by means of rods which can be pulled out after the core has been booked. These rods are of varying diameters and pierce each other in order to insure continuous vents. Fig. 20 shows the core box after having been booked, with the vent rods pulled out. The old style corebox, illustrated in Fig. 21, of which only a few now are left, does not permit of such facility and accuracy in making cores as the new booking boxes. The old-fashioned boxes also are in halves, of cast iron; the lower half is rammed independently, after which the top half is put on and rammed through openings or "pockets" in the shell. The old-style boxes, as is shown, also are provided with openings for vent rods. This old method requires much more effort and time on the part of the coremaker than is necessary with the modern equipment. All round boiler cores are rammed on pneumatic jolters, of which there are two, while the sectional boiler cores are rammed by hand.

Figs. 22 and 23 show the highly adaptable type of core truck developed at this plant for the rapid handling of sectional boiler cores. These trucks are 12 feet long, four feet wide and six feet high. The upright corner posts are provided with bracket pins which are spaced vertically from nine to 12 inches apart, depending on the height of the cores. On these bracket pins are placed horizontal cross bars which support the core boxes, as shown in Fig. 23. By means of this form of construction, the core trucks may be loaded and unloaded with the aid of the crane. In either case, the truck is built up as the loading proceeds, or dismantled as the unloading proceeds, and

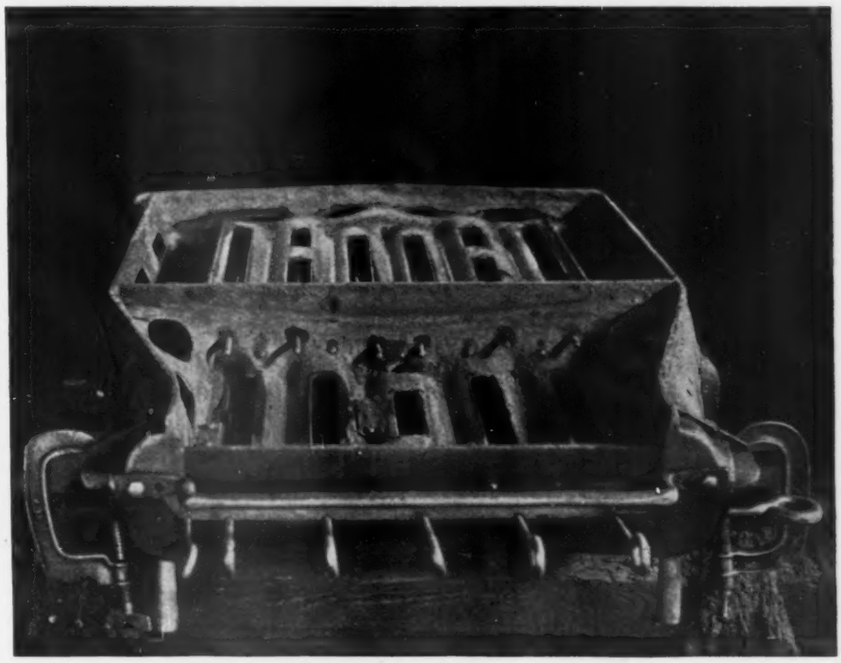

FIG. 21—OLD STYLE CORE BOX, SHOWING POCKETS FOR INTRODUCING AND RAMMING THE SAND

a truck thus may be loaded or unloaded in a very few minutes. The core department is equipped with two two-ton electric traveling cranes. These are operated from cabs by one man who, by means of an overhead transfer platform, can step from one cab to the other without delay. The core room also contains one one-ton electric traveling crane which is operated from the floor. From the core room the cores are taken to the foundry by means of the tram-rail system, which serves all departments of the plant. The round boiler cores are engaged by means of hooks which are baked into the core, while the sectional boiler cores are piled up, each on a separate board, after which the entire pile is picked up, by means of rods which are placed under

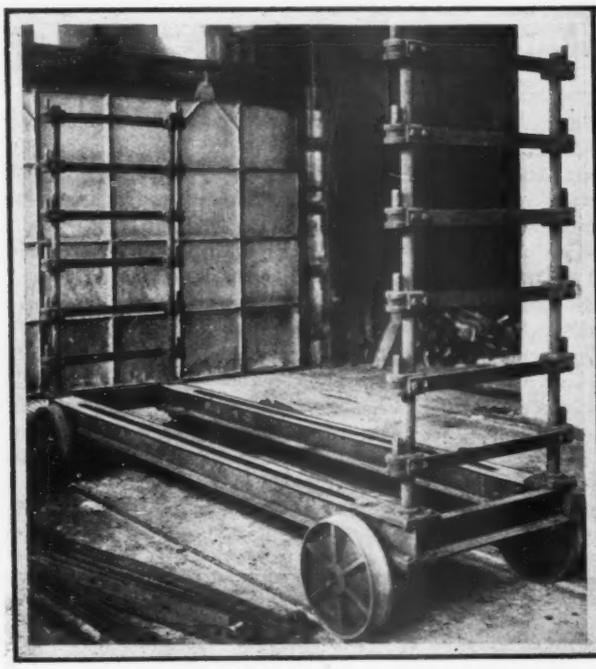

FIG. 22—CORE TRUCK, SHOWING FRAME WITH RACK DISMANTLED

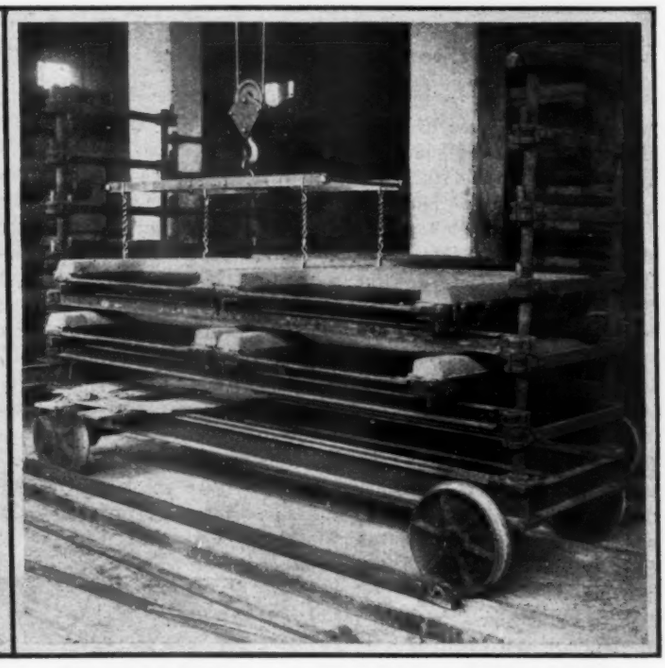

FIG. 23—BUILDING UP CORE TRUCK AS THE LOADING PROGRESSES

it, and transferred to a tram-rail trolley by means of the crane.

The core department is equipped with nine ovens. The coal storage is at the back of the ovens on the stoking level. From the storage, tunnels run alongside and in front of the furnaces, thus making it possible to stoke the furnaces without disturbing the workmen in the core department. Each oven is provided with a thermostat and a recording thermometer. To eliminate gases of combustion from the core department, there are rectangular flues over the entrance to each oven, all of these discharging into a louver on the roof.

The Joseph Dixon Crucible Co., Jersey City, N. J., has issued a very timely pamphlet showing useful Spanish words and phrases. The correct method of pronouncing Spanish words is explained in detail and a great number of words and phrases used commonly in dealing with Spanish-speaking people are given. The pamphlet is singularly valuable at this time in view of the efforts being made to broaden our trade with South American countries.

Commercial Oxygen Plant at Philadelphia

The Linde Air Products Co., New York City, will erect its twelfth commercial oxygen plant at the southeast corner of Eighteenth and Cambria streets, Philadelphia. The building will be one story high, fireproof throughout and of brick, steel and concrete construction. Its equipment will consist of the special Linde rectifying apparatus, together with the necessary air compressors, oxygen pumps, etc., all electrically-operated with individual drive. In planning the plant the Linde company is pursuing its customary policy of anticipating large increases in the sale and use of oxygen and, therefore, space has been allowed for doubling the capacity of the plant. The present installation is duplex and is calculated to produce an output of 2,000,000 cubic feet of oxygen per month. The ultimate output, when the second duplex unit is placed in operation, will be 4,000,000 cubic feet per month.

During the past two years the Linde company has built nine plants and others are in contemplation. It has been the policy of this company to facilitate the use of oxygen in the various industries by furnishing this commodity with as little expense for transportation as possible and at prices which are calculated to make oxygen available to any industry where a process of manufacture can be facilitated.

Providence Core Sand

The Whitehead Bros. Co., Providence, R. I., is making heavy shipments of core sand dug at Providence to many foundries throughout the central west. This sand has a round, uniform grain, is easily mixed with the binder and makes hard, porous cores. This sand has been used for many years in the foundries in Providence and immediate vicinity, but latterly a large demand has been created for it in casting plants located at distant points. This sand is particularly desirable for making cores for gas engines, cylinder work and for hardware and light machinery castings where a smooth surface is desired. It also has been found that a minimum amount of binder is required to make satisfactory cores.

The Robeson Process Co., Pennington, N. J., manufacturer of "glutrin," has combined its laboratories and has established an office at 18 East Forty-first street, New York City. Shipments, as in the past, will be made from this company's various warehouses and plants, but all correspondence should be addressed to the New York office.

Scientific Management in Foundry Operations

How Time Studies Can be Made in the Casting Plant and How the Work is Expedited Thereby

By Robert Thurston Kent*

THE foundry is just as susceptible of improvement in its methods and its products by means of scientific management as any other industry. In fact, in many respects, it is more susceptible to improvement than most industries. The reason for this is that in the foundry much of the work is done by hand, whereas in other industries the greater proportion of the work is the product of machinery. Machines can be standardized and their efficiency improved without even near approach to the tenets of scientific management. Scientific management has made its great strides, not in the improvement of machine efficiency, but in the improvement of the efficiency of labor. Naturally, therefore, an industry, the great bulk of whose product is made by labor alone without the use of machinery, offers a larger field for improvement than does one dependent upon machinery.

To the present time the foundry relatively has not received as much attention from scientific management experts as have other industries, notably the machine and textile trade. This is probably not due so much to the difficulty of handling a foundry under scientific management as it is to the fact that foundrymen as a class may not yet have been educated to the possibilities of this movement which has effected enormous savings in the other trades.

Scientific management, according to Frederick W. Taylor, requires that "each man in the establishment, high or low, should daily have a clearly defined task laid out before him. This task should not in the least degree be vague nor indefinite, but should be circumscribed carefully and completely and should not be easy to accomplish." The whole end and aim of scientific management lies in the setting of this task and its accomplishment. Every device that is adopted, every step that is taken, has only this one end in view. Any improvement which has no bearing directly or indirectly upon the setting of a task for any man in the works, from the president down to the coremaker, is not a part of scientific management. The setting of a task implies more than the mere scanning of a job and saying that it can be done in, say, 60 minutes and letting it go at that. That method of setting a task is the one that has been practiced from time immemorial under the name of piecework, and it is to avoid the evils of this method that scientific management steps in.

Responsibility of Foundryman

The foundryman who seriously contemplates the adoption of scientific management for the improvement of his foundry should take heed of the fact that he is imposing upon himself a far greater burden of responsibility for the success of his efforts than he is imposing on his workmen. He must needs do things for the men which heretofore he has been accustomed to having them do for themselves. He must provide them with equipment which is adequate to the job, which is standardized, and which is in perfect repair. He must set himself to learn the best methods of doing work, determining these methods by accurate, patient time study; and when they have been determined, seeing to it that these methods are converted into permanent records, and that the workmen are instructed in them. He must be prepared to spend more or less money in this work and he must be prepared to scrap more or less equipment which in the old days seemed "good enough", but which is not up to the new standards which scientific management will impose. And, above all, he must be prepared to accept rebuffs and discouragements, for it is natural that the men will look with suspicion upon many of the changes and may resent the setting of tasks and the institution of bonus and differential rate piecework for the straight daily wage under which they are accustomed to work. Eternal vigilance and patient reasoning with foremen and men, however, will accomplish wonders, and there is no case on record where the work has been approached in the right spirit and conscientiously carried through that it has been successfully opposed by the workmen.

Nor must the foundryman expect to accomplish a revolution in a short space of time. Scientific management involves more than any other one thing, a change in the mental attitude of both workmen and employers. Changes which are as revolutionary as those produced by scientific management cannot be accomplished in a week nor a month, nor can the physical establishment of the necessary standards and the determination of the proper tasks be made in any short period of time. The expert who tells a foundryman or other employer that he can reorganize his plant, install scientific management and cut his costs in half in six months is usually a charlatan and should be avoided like the plague. The woods are full of these so-called experts, and too strong a warning cannot be given regarding them. Although it is impossible for the foundryman to accomplish true scientific management in a period of less than two years, nevertheless the benefits resulting from a start being made will begin to accrue almost immediately. Let us see how this proposition works out.

The basis of scientific management is time study. By this we mean the analysis of every job into its component parts or motions and the timing of these elementary operations. A study of the list of operations and the time expended on each will soon reveal to the intelligent observer wherein the time has been wasted, either by the molder himself or by the management in not providing the molder with the equipment that he needs. A further study also will indicate what rearrangement of the work or methods could be made which would eliminate these motions and thus save a considerable amount of time both for the molder and the company.

Let the foundryman who is contemplating scientific management prove this for himself. Let him take a stop watch and go out into the foundry at 7 o'clock in the morning and time any molder during the morning or the entire day. Let him observe how much time is required by the molder in interviewing his foreman at the beginning of the day and ascertaining what job he is to start on. Let him observe whether or not the patterns are at hand or whether

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the molder must make a trip to another part of the shop to procure them. If so, find out how many minutes are expended in this work. Having procured his patterns, is the flask at the bench or on the molding floor? If so, is it of the proper size, or is the only flask available one in which several patterns must be bedded, requiring another trip to the foreman to procure these additional jobs. If no flask is ready for the molder let the stop watch tell how many minutes the molder expends going out to the yard and finding a flask that will serve his purpose. Let the employer note with the stop watch how many minutes the molder expends in hunting the carpenter, or in patching the flask himself, or in putting cross-bars in it.

Time Consuming Operations

Having finally got his flask in position, let the owner observe whether or not the sand is properly tempered and cut for the molder. If not, make a note of the time required by the molder in doing this? Let him also observe whether or not the molder puts his flask in such a position that he may get the sand into it with the least possible exertion and loss of time. Let him observe also whether or not the molder has all the molding tools at hand, and if they are in such a condition as to permit of rapid and efficient use. Or if it is necessary for him to borrow a rammer, a trowel or a slick from another workman, let him make a note of the time lost in borrowing equipment.

Has the molder been provided with an adequate supply of gaggers or soldiers of the right length, or does he have to hunt throughout the foundry for them, or perhaps improvise a set? How much time does he expend in doing this useless work?

When the mold has been completed, let the owner make a note of how much time the molder spends in slicking and patching due to a damaged pattern and then let him calculate how much of this time could have been saved had the pattern been carefully inspected before it was given to the molder and spike holes puttied up and splinters removed. Finally, let him observe when the mold is closed whether or not the molder carries it an excessive distance and ascertain how much time it required to do this.

If the foundry owner is truly desirous of improving conditions in his foundry, such a study will be a revelation to him. He will find in many cases, as the writer has often found, that the non-productive time devoted to items such as have been enumerated, amount to two to four times as much as the time actually spent in making molds. Truly, the owner could afford to pay the molder half as much again or twice as much if he could eliminate this wasted effort; and this is exactly what scientific management will do for him.

The time study outlined as made by the owner is one that would be made by the scientific management expert after the more obvious faults had been corrected. He would then lay down conditions in the plant which would remedy the defect and enable the molder to save time, effort and steps. He would make it possible for the foundryman to pay the molder 50 to 100 per cent more per mold than he pays under the present schedule with the resulting profit both to himself and to the workmen.

Let us see how scientific management would handle the matter under the reformed conditions which it would cause to prevail. It is unnecessary in this connection to go into the details of the planning which would accomplish the ends aimed at. For our purpose it is sufficient to show what will happen.

Each workman, when reporting for work in the morning, would find on the bulletin board instructions or job cards assigning to him certain jobs for that day. These instructions would tell him definitely what the job consisted of, how many molds were required from each pattern, at what molding machine or on what molding floor the work would be done, whether or not cores were required. Proceeding to the floor, he would there find ready for him the necessary flasks, the pattern or patterns, with instructions showing how the patterns were to be bedded-in the flask, if two or more castings are to be made in one flask. The patterns would be in perfect condition so that all patching and slicking would be reduced to a minimum when the pattern is withdrawn from the sand. He would have at his work place, together with the flask and patterns, an adequate supply of gaggers and soldiers of the right length, and also a supply of nails should the mold be one which required nailing. If the casting happened to be one requiring cores, the cores also would be ready for him, or in the event of a long job they would be brought to him in advance of the time needed, together with any chaplets which might be required. With this equipment he would also receive definite written instructions in the form of an instruction card showing the best method of making the particular mold in hand. This instruction card would detail every step of the process from the placing of the flask on the table to the closing and setting of the finished mold. It would give, in addition, the time in minutes or hundredths of a minute required for each of these individual operations. These times, under true scientific management would not be the result of guess or estimate, but would be based on accurate time studies and would show the time in which a good workman had done that particular operation before. The molder, after making himself acquainted with the best methods of the best workman who had preceded him—as he would be doing by a study of this instruction card—should be able to make the mold in the time called for by the card.

Molder Not a Pack-Horse

These times fixed by the instruction card would be based on the theory that the foundryman has done for the molder all that is required of him, such as the provision of flasks, tools and other equipment at the work place in advance of the time they needed. It makes no allowance for the molder hunting for any of the equipment which he is supposed to use. A skilled molder's time is entirely too valuable to be spent in useless labor. Patterns, flasks, gaggers, cores and other necessary equipment for his work are brought to him by low-priced laborers. The molder's business is the making of molds, not acting as a pack-horse, and under scientific management the molder would put in his entire time at molding, while laborers would be engaged to act as pack-horses.

We have seen that scientific management establishes standards of performance, necessitating in turn the establishment of standards of equipment. The first, while the most important, is, of course, dependent upon the second. The first step in putting a foundry under scientific management, therefore, will be a study of the equipment already in use and a decision as to whether or not it is the best for its purpose. If it is not, it should be discarded and the better equipment adopted in its place. However, it may and often does prove too much of a burden for a foundry at the outset to scrap a lot of perfectly good equipment because it is not the best that is adapted for its purpose. While, of course, the best equipment is always to be desired, still it is not so all-important as might be deemed necessary. The important thing is that all equipment be up to a given standard so that when the time of doing a certain job with any

given set of equipment is fixed, it will be reasonably certain that the time can be attained if the job is done with other equipment, but which is in the same class. Nothing is so discouraging to the workman as to find that it is impossible for him to make the time set for a job and then to learn that the fault is not his, but that of the management in not providing him with appliances as good and well fitted for their purpose as those used in the time study which fixed the task time.

Nor will the foundryman who neglects this important phase of the work reap any benefits from the setting of task times. He will either set times which are impossible of accomplishment due to the fact that the time studies were originally made on apparatus of the best and most suitable character for the job, whereas such equipment is not uniformly available throughout the foundry, or he will set times which give to the workman far too wide a margin, thereby making the piece price of each mold excessive and reducing his profits by just so much. The order of procedure therefore, is to modernize and standardize the foundry equipment and then with this standard equipment set standard times for doing each job which comes into the shop.

Similarity of Jobs

But it may be objected that foundry work is of such an immense variety that it is impossible to set tasks upon all of it or even a small fraction of it. "We never get the same job twice in three months", we hear the skeptical foundryman say. Quite true, but this is not necessarily a bar to standardizing as much of the work as possible. Because a man is unable to buy himself a seven-course dinner is no reason why he should despise a meal less pretentious. And the foundryman who looks into the situation carefully will find that although he does not get many jobs which are exactly alike he will find in all of his jobs a remarkable similarity between many of the fundamental operations entering into the completed work.

Probably the most complex mechanism that the foundryman has to handle in his daily work is the English language. Yet the English language with its thousands of words can be resolved into 26 component parts. In like manner, the foundry trade which has nothing like the complexity of the English language can be resolved into a comparatively few simple operations. For instance, consider green sand work with split patterns. Every mold requires the placing of the flask upon a mold board, the placing of the drag half of the pattern inside the flask and on the mold board; the riddling of a certain amount of sand over the pattern, and after it is covered the shoveling of the heap sand into the flask until it is filled and then ramming with either hand or power rammers, the striking-off of sand from the top of the flask and the turning of it over together with the mold board. Similar operations are gone through with the cope portion of the mold. It is obvious that each one of these simple operations can be timed and roughly classified according to the size of the pattern, which in turn determines the size of the flask.

For instance, all 12 x 18-inch flasks would require approximately the same amount of time for placing upon a mold board. As under scientific management the size of the flask would bear a somewhat definite relation to the size of the pattern, a unit time which would be approximately correct, could be determined for riddling sand to cover the pattern in all 12 x 18-inch flasks. In like manner, a fair time allowance could be determined for filling with heap sand a 12 x 18-inch flask containing a pattern of a given volume. Thus a pattern of certain dimensions would require say six shovelfuls of heap sand, while a slightly larger one would require but four, or a slightly smaller one eight. It is surprising how quickly and accurately an experienced instruction card man can analyze a job in this manner and tell just what procedure should be followed, and in this case how many shovels of sand should be allowed for a given pattern. In like manner, times can be set for ramming a pattern of any known volume in a given flask, as this time again will be dependent upon the amount of sand, which is known from the previous operation. In like manner all the times of the component operations entering into the completed mold can be ascertained and determined by time study for a vast number of different classes of work. It is a comparatively simple matter after this has been done to make the proper selection of elements and thereby set the time for almost any job entering the foundry.

The time allowed for making a mold of any character whatever will be considerably less when the method outlined above is followed than the time consumed with the methods usually in vogue, where the molder finds his own equipment and has not a standard line of procedure laid down for him. The time allowed may easily be one-half or one-third of the time under the old scheme. It does not require any great stretch of imagination to ascertain what this means to the foundryman. With a given force of workmen the capacity of his foundry for castings can be doubled at no expense, except for the improvement required in standardizing the equipment. Increasing the capacity of any plant without a corresponding increase in overhead expense means an increase profit upon every pound of output. In all fairness, this increased profit should be divided between the foundryman and the molder in the shape of a premium or bonus to the molder who finishes his work in the times allotted by the instruction card based upon time study.

This increase in profits, important as it may seem, is one of the smallest resulting benefits of scientific management. The possibility of accurately predicting how long it will take to do a certain job will enable the foundryman to make definite promises of delivery when he receives an order and to keep these delivery promises absolutely. There is no necessity for arguing that the foundry which gets the reputation of delivering every casting on the day it promises to do so will secure business regularly, even in competition with other foundries which will promise shorter deliveries, but which also have the reputation of keeping these promises not over 50 per cent of the time. A reputation for accurate delivery promises is one of the greatest assets that a foundry can have.

Routing the Work

The formulating of tasks and the writing of instruction cards from time study is but one small department of scientific management, albeit the most important. To make the greatest possible use of the advantages of standard times, arrangements should be made for scheduling the work to be done so that it will be allotted to the workmen in ample time to have the molds and cores made and the castings poured in accordance with the promised shipping date. Other arrangements also should be made for routing the work so that each molder receives that character of jobs for which he is best fitted. Scientific management also will provide scheduling the work so that castings requiring special analyses of iron will be molded and poured so far as possible on the same day to save trouble and possible mistakes in mixing upon the charging

platform. In fact, there is no detail of the entire conduct of the foundry business from the receipt of the order in the office to the loading of the finished casting upon the truck or railroad car for shipment which scientific management will not analyze and standardize as it will for making molds as previously outlined. Each foundry, however, must be considered in these respects by itself alone. No hard and fast system can be laid down to fit all foundries, but the details must be worked out in each case to fit individual conditions.

Why the Analysis

By W. J. Keep

Question:—We ran short of No. 2 pig iron recently and increased our 6 per cent silicon pig to 16.20 per cent of the mixture, the remainder being nearly all stove plate scrap. We used the same amount of coke as usual and the iron came hot. However, we have experienced considerable difficulty due to the iron solidifying quickly. Our product consists of medium weight machinery castings. On the day following this experience we used about 5 per cent of the 6 per cent silicon pig, together with about 26 per cent of the No. 2 pig iron, which contained 2.40 per cent silicon. We had no trouble due to the iron solidifying quickly in spite of the fact that during the last few days we have been using slightly less coke than formerly. The following is an analysis of the castings referred to: Castings poured on July 15, graphic carbon, 2.60 per cent; combined carbon, 0.47 per cent; silicon, 2.95 per cent; sulphur, 0.081 per cent; phosphorus, 0.504 per cent; manganese, 0.48 per cent. Castings poured on July 16, silicon, 2.14 per cent; sulphur, 0.084 per cent; phosphorus, 0.548 per cent and manganese, 0.52 per cent. Would the percentage of silicon used have any effect on the first analysis, or is the phosphorus too low? Was this analysis influenced by the small percentage of pig iron used? We understand that phosphorus influences the fusion temperature and that an iron high in this element will remain fluid longer than one lower in phosphorus. Is the iron affected in this respect by the percentage of total carbon?

Answer:—Stove plate is about ⅛ inch thick and the grain always is close. Portions of the stove plate scrap have been in contact with burning fuel and the carbon has been decreased. The sulphur is always high. The total carbon in No. 2 pig is always higher than 3.25 per cent and is generally 3.50 per cent. Silicon acts on carbon, changing combined carbon into graphic and thereby makes the molten iron more fluid and it will not freeze as quickly as with less silicon. On the 15th of July the total carbon was 3.07 per cent and with this low carbon no amount of silicon could change the 0.47 per cent of combined carbon to graphic. In other words, the iron is not saturated with carbon until it approximates 4 per cent. With saturated iron an increase of silicon causes some of the graphite to be dropped and it appears on the surface of the molten iron as kish, stodge, dirt, or whatever other name the molder calls it. This skum is apt to get into the gate and shows in the casting as dirt. The only way is to use sufficient scrap to reduce the carbon. However, stove plate scrap is made from the best grades of pig iron high in carbon and drops more of its carbon than any other class of castings. It, therefore, is not desirable as scrap except to reduce carbon. It is more economical to use machinery scrap and a cheaper pig iron containing less carbon than No. 2.

It is unlikely that phosphorus reduced the melting temperature of pig iron or that it makes the melted iron more fluid, but it causes the iron to remain fluid much longer, which is the same thing to a molder, as he can fill his mold after carrying the iron a long distance from the cupola. If the phosphorus has been 1 per cent, it might have helped a little, but the iron must contain at least 3.25 per cent of carbon to work satisfactorily. Stove plate scrap has been found to be desirable for making radiators and cast steam boiler sections because it closes the grain and the iron generally is clean if the scrap is not too rusty and does not contain too much dirt. However, for general use it is not desirable scrap and too much of it must not be employed. The sulphur always must be kept low, as stove plate scrap is always high in this element.

Hard Castings

By W. J. Keep.

Question:—We are engaged in the manufacture of light hardware, and the food chopper worms which we produce are too hard to machine readily. We use only one brand of pig iron containing silicon, 2.97 per cent; sulphur, 0.038 per cent; phosphorus, 0.58 per cent, and manganese, 0.67 per cent. Our cupola is lined to 36 inches and we charge 550 pounds of coke on the bed with 600 pounds of pig iron, 200 pounds of remelt, 100 pounds of shot iron and 100 pounds of broken castings. Our blast pressure varies from 8 to 10 ounces.

Answer:—It is never safe to use a single brand of iron in your mixture. The silicon in your castings, of course, is lower than in your pig iron, owing to the cupola losses. We would suggest that you purchase high silicon iron and use it for increasing the silicon content of your mixture. Until you can obtain a supply of high silicon iron, we would suggest that your first charge be made all pig and that your food chopper worms be cast from this metal. A small piece of pure aluminum added in the ladle will also aid materially in softening your castings.

Unnatural Shrinkage

By W. J. Keep

Question:—On July 24 and 27 our test bars analyzed as follows: July 24, silicon, 1.90 per cent; sulphur, 0.054 per cent; phosphorus, 0.595 per cent and manganese, 0.41 per cent. July 27, silicon, 2.11 per cent; sulphur, 0.072 per cent; phosphorus, 0.70 per cent and manganese, 0.52 per cent. The average shrinkage on July 24 was 0.15 per cent and on July 27, 0.139.

Answer:—I do not know how to account for this and it might be attributed to the fact that you have made a mistake in your shrinkage measurements. However, there are instances wherein neither chemical analysis nor the measure of shrinkage will indicate the cause for the peculiar behavior of iron. As a general rule, if other elements and conditions are the same, an increase in silicon will cause a decrease in shrinkage, and vice versa. If I knew as much as you do about what you use in your mixture, or if I knew how you prepared your test bars. I might be able to give an explanation of this difference in shrinkage, but there are still a few unexplainable features about cast iron.

Time of Malleable Heats

By Harrold Hemenway

Question:—What is the every-day practice and the time required for melting 7, 8, 9, 10, 11 and 12 tons of malleable iron in an air furnace from the time the blast is put on to the time of pouring? What is the time required for making the first heat for these various tonnages, as well as the second heat, with the furnace in good working condition? What blast pressure should be used? The blower installed in our plant is a No. 7 Monogram and we melt two heats per day. The first heat is tapped at 11 o'clock and the second at 4:30 p. m. The iron for the first charge is charged on a cold bottom, or in other words, it is charged into the furnace after the second heat is off and the iron is permitted to lie in the furnace until the next morning. Is a greater time required for making the first heat than the second heat? I understand that melting two tons of iron

per hour in an air furnace is excellent practice, but I would like to know whether this applies to the first heat only, or to both first and second heats. Of course, the second heat is made in a shorter time than the first heat.

Answer:—The time required to melt 7, 8, 9 and 10 tons of malleable iron in an air furnace follows: 7 tons, 3½ hours; 8 tons, 4 hours; 9 tons, 4¼ hours and 10 tons, 4 hours and 40 minutes. This is the average time required to melt these heats, as it has been my practice to charge the first heat on a hot bottom and there is no difference in the time required for melting first and second heats when the furnace is working properly. The first heat requires a longer time, owing to the fact that the furnace is not as hot as when the second charge is made. This time is taken from the lowering of the bung after charging until the time of tapping the heat. The blast pressure for malleable practice ranges from three to eight ounces. Late practice tends toward increased volume at decreased pressure. The diameter and number of the top blast pipes can be arranged to obtain good results if the pressure is between these two points. I have not given the time required for melting 11-ton and 12-ton heats, as I have not melted heats as large as these for some time and am not posted on this work at present. A change in the mixture at times can be made which will make the charge melt faster.

Ganister Lining in Side Blow Converters

By John Greyson

A GREAT deal has been said and written about side blow converters, both in praise and condemnation. Every steel maker is familiar with Mr. Simonson's excellent little volume on the subject, and will recall that he advocated a ganister lining. The occasion for this article is a remarkable run made recently by the Sivyer Steel Casting Co., Milwaukee, when using a complete ganister lining in its one-ton converter. Twenty-three blows were made in a single day; 30 blows were made in two consecutive days the following fortnight; and 203 blows in 13 blowing days in June.

Now the vital problem in side blow converter practice is the lining, and it must never be forgotten that the lining of a converter has to be more than heat resisting. The fact that silica brick are used in open-hearth furnace construction is no reason that they are the best material for side blow converters. The function of an open-hearth roof is to reflect heat, and it is never called on to stand the cutting action of the oxides formed during refining. The converter lining, on the other hand, must resist a greater absolute temperature than the open-hearth roof and at the same time be subjected to direct contact with the oxides. The actual conditions under which the oxides are formed are different in the two furnaces. In the open-hearth the source of temperature is a gas or an oil flame and the reactions take place slowly under the eye of the melter, the amount of heat given off by the oxidation being negligible. Consequently the furnace is always hotter than the bath. In a converter, the forming of the oxides produces the temperature and the reactions are quick. Also the heat, after the carbon flame, is augmented by the burning of CO to CO_2 and is far greater than in an open-hearth furnace. Hence the converter lining is at a lower temperature than the bath and subjected to a more severe test than is the lining of an open-hearth furnace. Furthermore, in a one-ton converter, owing to the smallness of the bath and the consequently more rapid changes in the metal level, the reactions have a much more marked effect on the lining than in larger converters.

For three months after the installation of a one-ton converter the practice was standard. The converter was lined with silica brick and brick tuyeres were used. The bottom was knocked out at the end of each blowing day. Repairs were made with a mixture of silica grits, silica molding sand and fire clay. With that practice, eight to ten blows a day were made, and all the metal was taken from the converter in hand shanks. As time went on it was noticeable that the amount of repairing material used was increasing from day to day. In chipping away the slag, pieces of brick were frequently loosened up and fell out, until finally there were no brick left just above the slag line and on the back side. Burns through occurred and heats were scrapped. It was evident that the repairing material was not of sufficiently refractory nature to allow an average of ten blows a day to be maintained.

Ganister Mixture Tried

It was decided to try a ganister mixture for repairs, and one was procured with a rock base that ran about 99 per cent silica, crushed and mixed with specially prepared fire clay. The first day's trial proved conclusively that the move was in the right direction, and a ganister lining throughout the converter was substituted for the original one of brick,—which was in very bad condition after three months of service. This lining held up so well that it was found practicable to leave the bottom in for two or three days. By running the blower at low pressure for three or four hours at night, the converter was cooled sufficiently to allow a man to stay inside long enough to affect small daily repairs, and an average of ten blows was easily maintained. At that time more metal was needed, and to speed up operations the finished metal was poured into a large ladle and shanked from that. This is a standard practice, of course, in two-ton converters, but the one-ton converter was unable to stand up under the strain, with only a few minutes between blows. A repetition of the trouble originally found in the silica brick lining took place. In order to further increase the refractory nature of the mixture, a small amount of crushed rock without any fire clay was added to the original mixture, and after a few trials a combination was secured which allows practically continuous blowing.

These facts are brought before you as matters of interest because the use of silica brick in converters is nearly universal, and it is hard to see a reason for it unless it be that the proper way of using ganister is so little known that men hesitate to experiment after one or two failures. Only a few shops use ganister entirely, most operators having some pet repairing mixture which they apply on a foundation of silica brick.

Perhaps one difficulty for the beginner is the necessity of finding a substitute for the customary brick tuyeres. A plate may be made to bolt over the opening onto the wind-box, with bosses drilled and reamed to hold pipes. Great care must be taken to have the center of the holes come in the same plane, as it is essential to have the tuyeres level and plumb when the converter stands vertical. Such a plate can be made to fit any style of converter.

The tuyeres having been set in an empty shell, patterns have to be made in accordance with the shape of the con-

A paper presented at the Chicago meeting of the American Foundrymen's Association.

verter, for ganister must be rammed not muddled on. In a vessel that has a movable section, permanent forms are cheapest. On a drop bottom converter, rough lumber can be knocked together and then burned out. In any type of shell it is advisable to use the rough timber in the bottom or tuyere section, as frequently drawing out of a form disturbs the ganister around the tuyeres. The ganister itself should be put in around the forms, in small quantities, and rammed solidly and evenly with an air rammer, save at the tuyeres. At that point the greatest care must be exercised and it is better to use the peen end of a hand rammer.

The cost of the original linings in a one-ton converter will show little difference between silica brick and ganister, but there is a big saving of time and material in the daily repairs by the latter method. When the tuyeres are badly burned away, the old pipes can be drawn out and replaced by new ones, which is a distinct advantage over the old way of ramming ganister around a stick. There is always a soft spot where the patch joins the old lining and the air gradually blows the hole bigger. In one shop where a two-ton converter with a ganister lining is used an average of eight blows, five days a week, has been maintained for months. It is frequently possible to run an entire week without touching the tuyeres, and no repairs inside the vessel save small patches on the belly. In a one-ton converter the same bottom and tuyeres often last four days with an average of 30 to 36 blows those four days.

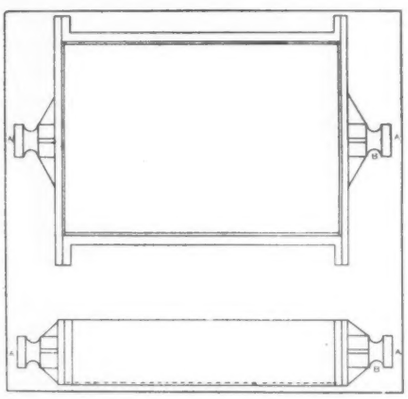


FIG. 1—CAST IRON FLASK WITH TRUNNIONS CAST SOLID TO ENDS

The greatest saving of all, however, is in the peace of mind of the blower. It is not nearly so easy as it looks to turn down blow after blow correctly, and it should always be kept in mind that 95 per cent of the results are not up to the converter itself, but to the operator. When the lining stands up the nervous tension is reduced to a minimum, and the answer is good steel for the foundry.

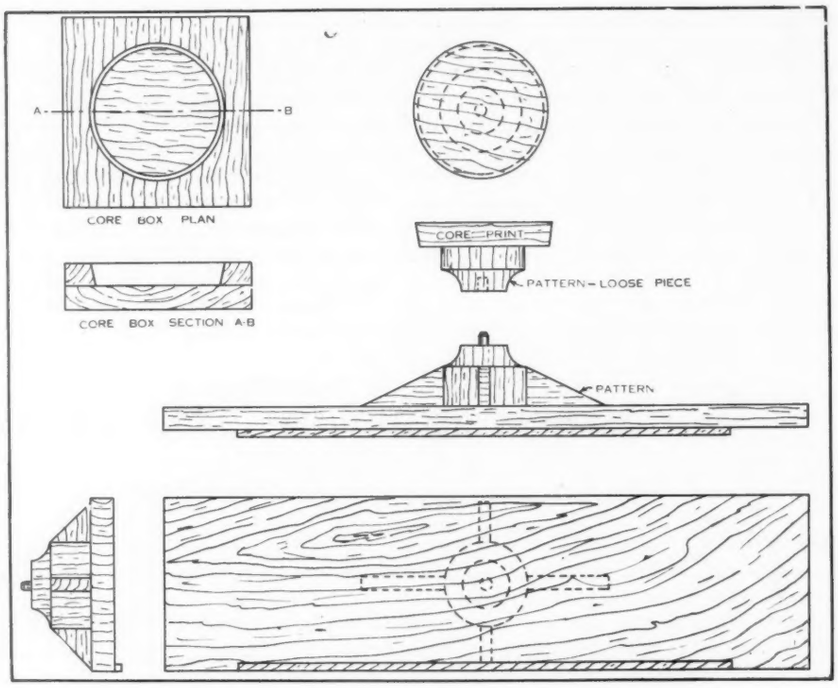


FIG. 2—PATTERN FOR END OF CAST IRON FLASK

Molding Cast Iron Flask Parts

By John Sweich

In making cast iron flasks similar to that illustrated in Fig. 1, trouble is sometimes encountered through the trunnions not coming true in the recess *B*. If the flask is molded and parted horizontally, a fin is formed which must be filed or machined off. If the trunnions are molded in dry sand, they may come out rough or the cores may shift and spoil the job.

These difficulties, together with the use of a three-part flask, can be avoided by dividing the trunnion pattern into two parts and using a special core print in a two-part flask.

The details of the pattern are shown in Fig 2. The trunnion is doweled together and furnished with a circular core print, as indicated. A dry sand stop-off core is made in the core box shown at the left in Fig. 2. It is the same size as the print on the trunnion pattern.

The mold is made in the usual manner, but before the pattern is drawn, the sand in the cope is scooped away from the core print, as shown in Fig. 3. The trunnion part of the pattern is then lifted out, after which the stop-off core is set in place in the recess left by the print, and the hole in the cope is refilled with green sand. The main pattern is then drawn out and the mold is finished and poured in the usual manner.

An Unusual Forge Fan

The Toronto Railway Co., Toronto, Ont., recently installed a set of fans built by the B. F. Sturtevant Co., Hyde Park, Boston, Mass., which is exceedingly unique in design. The set is for use in the forge shop operated by this company and both the blast and exhaust fans are mounted on the same shaft. The blast fans are for a number of small forges and the duct extends underground. The exhaust pipe from the forges to the exhaust fan also are placed underground.

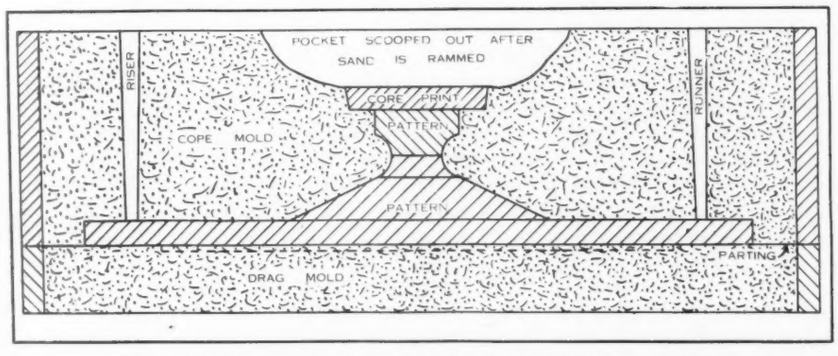


FIG. 3—MOLD RAMMED, WITH SAND SCOOPED OUT OF COPE

Operating a Foundry on a Scientific Basis---I

How the System Was Introduced in a Large Detroit Shop Specializing in Aluminum Castings

By Frederic A Parkhurst

AS a general proposition, the foundry offers neither more nor less in the way of difficulties to be overcome when installing scientific management than do other lines of business. There is no hard and fast rule to be followed. Each case, each kind of business and each different plant presents its own peculiar problem. On the other hand, the possibilities under scientific methods are greater in the foundry than perhaps any other metal industry. The following will be confined entirely to the author's personal practice and experience.

In the early stages of reorganization work there are many preliminaries to work out. Many of these affects those "higher up". The study of the personnel is in itself a task not to be lightly considered. After these are many problems which cannot be even approached until the co-operation of certain individuals is assured. It would take a good size book, perhaps more than one, to cover this one phase of the many things the organizing engineer has to contend with. The space here available will not permit of a discussion of the whole subject but special attention is called to the two following general subjects.

Office and Shop Personnel

Too often the office personnel has a tendency to imagine that they have special privileges that are not to be accorded the shop employes. Because their particular specialty gives them a shorter work day they should not take advantage of that fact. They should realize that they have greater obligations to their employer than any other employe.

The obligations of the office man are greater because as a class he is of better education, and has greater individual responsibility. He is often in possession of a vast amount of valuable information, all of which is the property of the firm. It is not his own. He must do his work and fulfill all the functions of his position with absolute impartiality. He must not let personal likes and dislikes in any way influence his relations with those with whom he comes in business contact.

Office operations as a whole are handled fully as inefficiently as are shop operations. In fact, some of the marks of "efficiency" are even lower than can be found in the shop connected with that same office. Very often the inefficiency of the office man will prove much more costly to the firm than will a comparatively low mark in the shop end.

Another point not to be lost sight of is that the less educated and more limited shop man is very prone to follow the example set him by his superior, or those occupying higher or more lucrative positions. It can be seen how far-reaching "higher up" inefficiency may prove.

Office Efficiency First

The shop employe is smart, and he who takes him for a fool "fools" himself. The office, including the planning room (which is the real brain of the shop organization), must in itself be most highly developed and efficient before maximum shop efficiency is possible. Likewise, a business which is all office departments, offers all the opportunities for scientific management that can be desired. Such a business must eventually adopt such methods to compete successfully in its particular field.

In definitely placing the responsibility in thoroughly defined organizations, such as that being described, it is important that individual feelings be considered. In other words, although discipline may be strict all investigations should be perfectly impartial and justifiable. No manager ever lost any prestige by any decision which he was forced to make, provided he was perfectly just and based such decision on unquestionable facts.

If there is one thing which will disrupt an organization quicker than any other, it is the habit of tale bearing. Criticising one man to another, particularly when you are talking to subordinates, is equivalent to the same thing, subordinates should not be allowed to carry tales or pass criticism about others. Of course, the management should be governed by exactly the same policy. As stated in the earlier part of this article, the shop man and the rank and file are great imitators. They are very prone to follow the example set by their superiors.

A great deal of harm has been done by thoughtless criticism on the part of men in authority, especially when directing these criticisms against their superiors. Talk of this kind is more or less injudicious and always has one effect—that of disrupting the best organization that was ever developed. The fact is often lost sight of that a company's policy and very often specific orders are *apparently* open to question. On the other hand, were all the facts known which led up to the establishment of this particular policy, or the issuance of that order, perhaps the person criticising the same would have an entirely different understanding.

Methods of scientific management are based on certain well defined principles. As first stated, the method must be suited to the local condition and the particular problem in hand. Without too much general discussion it will be well to briefly outline the few chief elements necessary to maximum shop efficiency (hence production), maximum prosperity to the individual and low costs. The realization of these conditions must result in placing the firm, employing these methods, in position to develop an enviable position in its particular field. It will be in position to compete fairly and successfully for its business. It can also hold the esteem as well as the business of its customers; all because of service, quality, price of its product and reliability of deliveries. These conditions cannot otherwise be fully realized.

Sales Department Development

Comparatively early in the period of transition from the old to scientific management, it is necessary to prepare for the development of a highly efficient sales department. This department is the business getting machine which makes possible the greatest shop efficiency. It must be up to date, efficient in itself and properly articulated with the shop organization. The kind and size of a business,

Presented jointly before the American Institute of Metals and the American Foundrymen's Association at their recent annual meetings at Chicago.

existing competition, probable future growth and the plant and plant organization which is to support the work of the sales department, are all vital factors to be considered in its development.

The speeding up of the sales end presents many peculiarities of its own. For this reason it is important to consider sales expansion as early as possible. We must consider the sales department as the business getting machine. Though our plant under the old methods may be overworked, it is more than likely to be running far below capacity when all departments are operating efficiently.

The demand to be put to the business getters of an organization when the producing plant (or plants) become highly productive, are seldom, if ever, realized by the former as early as would seem natural. Very often the sales department seems loath to admit the possibility that they themselves need speeding up. Arguments are often put forth when their department is approached, to the effect that "the shop needs tuning up", not they. Also to the effect "that when the shop can get more efficient and when it can deliver the goods somewhere near on time, then, and then only, will it be time to worry about us".

It is perhaps natural that this attitude often exists. Read the files containing innumerable complaints from customers—deliveries months overdue and quality way below par. Other common and by far too numerous complaints are emergency orders, seemingly ignored and profitable work in the customers' plants tied up for want of parts, shipments ordered by express go forward by freight, too much delay after getting an order in finding the specifications incomplete, time lost in much correspondence to settle details to enable the shop to proceed; this delay by the way often is up to the customers. To cap the climax it often happens that the order long delayed has been incorrectly filled. These and many more familiar examples can be quoted to support the complaints of the sales department referred to above.

Before proceeding further, it may be well to go into the all important matter of quality, both as to workmanship and material. Modern business is demanding more and more in this respect. It is a factor which is becoming more important daily. Combined against by quality and reliable promises as to delivery and service, price often has to take secondary place.

With a highly organized and efficient plant, price, though important, is no longer the sole controlling factor. If a customer can be assured of quality first and reliable and adequate deliveries, he cannot afford to patronize the lowest bidder who cannot win his confidence in regard to the first two factors. Scientific management does not, however, realize for the owners of a plant so run only high standards of quality and schedules of shipments as regular as the train schedules of our best railroad service. It goes further and gives the lowest and most reliable cost to the producing plant; hence the lowest prices can also be quoted with the assurance of a fair profit as well. Unfortunately we cannot await the fulfillment of the prophesies in the last two preceding paragraphs before undertaking the "tuning up" of the sales department. Therefore, as previously stated, this department cannot be blamed too much if not over-enthusiastic at the attention about to be bestowed upon it. To wait too long, however, is costly for several reasons. The improvement in shop methods is slowed down and often in danger of total collapse unless plenty of work is always available for men and machines. This is particularly true at certain critical stages in the organizing engineer's work. Take for example the preliminary work prior to realizing intense production and the payment of bonus. This is difficult in the extreme, even under ideal shop conditions and with plenty of work. When the shop has but little to do and the men are working from hand to mouth, so to speak, it is a long, tedious and delicate problem to handle. It may at times be even a hazardous undertaking. We are all human; under unfavorable conditions the workman is not going to work himself out of a job (as he believes) by high output no matter what he is paid, if he can help it. Though it takes from one to several years (generally the latter) to realize maximum shop efficiency, the improvements in shop conditions will be felt much earlier. The sales department must therefore begin to extend itself much earlier than the layman may realize. This is true for several reasons. Doubling the capacity of a plant by

FIG. 1—THE FACTORY BOARD IN SESSION

putting it under scientific management is not unusual. In fact, it is a conservative estimate which can easily be proved by the reader. This condition the sales department must meet by providing double (or more if the selling price is less) the amount of orders, or else productive plant is forced to lie idle. If this happens an undue proportion of "over-head" enters into the total cost of the product actually turned out. Will the sales manager welcome this extra charge if added to his cost of selling? No! But with business to be had, where else does it rightfully belong? There must be a maximum limit of overhead that can be rightfully charged to costs. This must be based on a fair normal production. A greater overhead due to lack of business is a distinct operating loss.

individual case must, of course be diagnosed and treated individually as to detail; don't wait too long.

To meet changed operating conditions and a plant capacity two or three times the figure once considered 100 per cent capacity, the sales department must prepare to supply a larger volume of business as time goes on. The support of a well balanced organization, backed by prompt deliveries and low costs (the latter permitting of lower selling prices) all help to promote larger sales. Early in the change of conditions this fact will not be easily recognized by the sales department. As time goes on, however, the sales department will be in position to utilize highly efficient shop methods as an important selling factor.

The sales department too often has much to contend with through customer's complaints caused by an inefficient plant.

its constituent parts and the routing of all its many operations.

b—The control of purchases and all material in storage as well as that in process of manufacture; also the sequence of operations according to a predetermined schedule. Material standards.

c—The control of equipment and tools.

d—The control of methods and determinations of standard operation times, including the distribution of help and the "balance of labor."

e—Control and standardization of wages and bonus based on individual efficiency.

f—Analytical costs and accurate data for estimates, including departmental indirect expense, thus making it possible to practically predetermine costs.

As soon as an order is received it must be examined in the sales department. If correct as to specifications, price, terms, etc., it should be approved and passed to the production clerk in charge of the planning room. He will examine it and check up the specifications to see that it is sufficiently complete to allow of its proper routing to the shops. It is essential that each order

FIG. 2—AT WORK IN THE PLANNING ROOM

If we realize a greatly increased production and a lower net selling price, as we surely will do, we may naturally expect a greater demand for our product. Competing firms may at first cut prices temporarily. Whether they can stay in the race or not does not alter the fact that the sales department under discussion must be in position to meet this extra activity of the competitors—legitimately, of course. The above statements must not be construed as necessarily advocating the reduction of prices.

Other changed conditions too numerous to mention, some local and others due to changed shop conditions, growth in volume of business, etc., further affect the methods to be employed in modern selling. Each

The shop organization is slow to realize this fact. When shop conditions and methods so shape themselves that the old time troubles disappear, there will soon be developed the closest harmony between customer, sales department and the operating end.

Scientific management throughout the entire organization has a far reaching and ideal effect. This condition is also felt by the customer. The customer's schedules and source of supply give him no trouble. His confidence is strengthened and he is perfectly satisfied. After all is said and done, satisfied customers are the keystone of the arch that supports any business.

Briefly the functions of the planning room, Fig. 2, consist of—

a—The minute analysis of each order into

have the date of completion specified. If shipments are to be made at a certain rate per month this should be clearly stated. It is not sufficient to call for completion "at once", "hurry," or "rush." These terms mean absolutely nothing; they can be only comparative.

The next step is to record the item on the production card. This card is a general record or history of that particular pattern. Every order for castings from one pattern is recorded on the one card. As soon as the work is in process the daily history of the job is recorded. This history includes;

1.—Total castings made each day.
2.—Number of defective castings each day.
3.—Net good castings each day.
4.—Total good castings made to date.
5.—Total castings shipped to date.

This card has capacity for eight

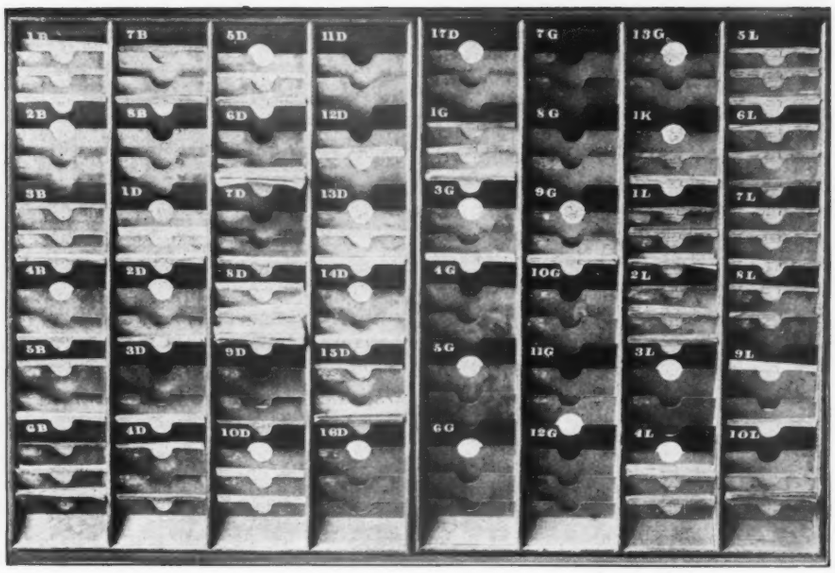


FIG. 3—DETAIL OF ONE TYPE OF PLANNING BOARD

months, at the end of which time a new card is started and the first one filed in a transfer file.

After the production card record is started, the order is passed to the route clerk. The route clerk issues the necessary "work orders" to each department in which any work is to be done. These work orders are issued to cover specific operations. If the pattern has 25 different core boxes a work order is made out for each core box and for the total number of cores required from the box, twenty-five work orders. The mold room receives a work order for the number of castings required. The work order also specifies the number of men to work on the job. Work to be done in other departments is treated in a similar manner. The work orders are issued in duplicate; one to the shop board and one to the planning room board.

As a guide to routing work in the core rooms the route clerk has a "standard core routing record." This record shows the number of each core box, the name of the core, the bonus chart number for each core and its nominal standard routing. For example, if the standard routing specified is 1C1 it is understood to mean that any bench from 1 to 10 inclusive, in number 1 core room (1C) can make the core.

In further explanation of the above it should be noted that the coremakers, as well as other employes, are divided into grades, generally three. In the core rooms, as a case in point, one grade of coremakers work at benches 1 to 10 inclusive; another grade at benches 11 to 20 inclusive and the third grade at benches 21 to 30 inclusive. To distribute the work to advantage the route clerk has but to glance at the planning board, Fig. 3 to tell what bench in any grade is available. If all benches have work ahead, or if but a given number are in operation, he issues the work order to the bench having the least to do in that grade.

Of course, there are special instances whereby the above routine may be departed from. The method is perfectly flexible. The conditions are so under control that it takes but a moment to tell the correct routing of any job. The same general scheme is used in routing work to other departments. Machine work should be routed directly to the machine; symbols are used exclusively as a means of identification. Section 8 will give some detail as to how the symbol scheme is developed and used.

Scientific routing of work in process tends to eliminate many false moves and generally expedites the movement of material through the shops. It is necessary to route work specifically by operations; else the control of it from the planning room is impossible. It will be seen that this method practically eliminates the foreman as a factor in distributing work in his department. Routing is developed as a specialty under scientific management. One man, the specialist, soon becomes more competent (with the aid of the planning board) to distribute work than the best foreman. This method also has quite a value as a cost reducing factor. The balance of work on hand, separated into its various grades is always *immediately* available. This makes possible the control of the labor *necessary* to be expended daily to handle the work actually in process, and only in the *required* amounts. This will be further referred to later.

The Control of Material and Operations

The order-of-work clerk is responsible for the processing of work according to schedule. To assist him in this work, it is necessary to maintain several schedules. This part of the work is done by the schedule clerk. The schedule clerk also assists the order-to-work clerk in following up operations. He advises as to the status of work in process not coming through in accordance with the predetermined plan.

The process schedule is made out after the issuance and routing of each order. Some of the planning of the various operations is done exclusively by the order-of-work clerk. Other factors affecting the order of processing must be determined by consultation with the superintendent, foreman, time study foreman and others. To properly control work in process, frequent conferences are necessary. To this end the factory board is brought into existence.

The factory board, Fig. 1, is generally

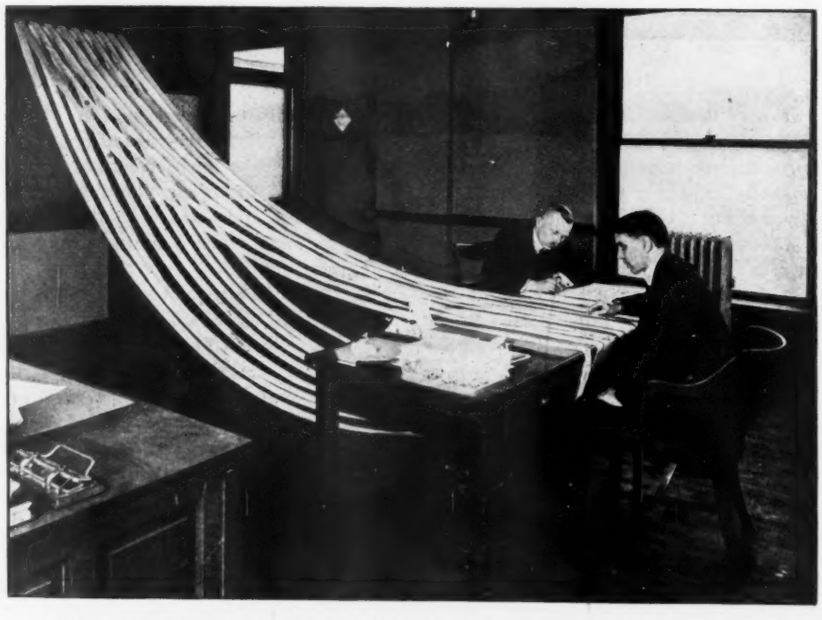


FIG. 4—APPLYING SCIENTIFIC METHODS TO FOUNDRY OFFICE WORK

made up of the organizing engineer, superintendent, mold and core superintendents, production clerk, time study foreman and the order-of-work clerk. Meetings are held daily except Saturday if it is only a half day, otherwise six days a week.

All important matters affecting the general management of the shop are brought up at these meetings. The general orders are gone over at frequent intervals. Deliveries are planned in a broad way. Departmental work is also taken up in more or less detail depending of course on the condition of work in the various departments.

One important matter to receive attention daily is the analysis and study of the production report for the previous date. Unusual losses due to defective castings, lack of material (especially cores) or faulty equipment, are taken up in detail. Costs for the previous day are also given most careful thought. The cost of all the different classes of castings made the day previous is known each morning by 10 o'clock. This is an important controlling element. Knowing the cost each day makes it comparatively easy to remedy a condition resulting in a higher cost; likewise, it is easy to take full advantage of a low cost condition.

It is at these meetings that the order-of-work clerk takes up many of the matters he must settle to bring his work in process through on schedule time. Such planning is most important; without it a railroad like schedule cannot be maintained. The frequent change of shipping specifications on the part of a customer is one of the very frequent occurences. Yet even this is not so serious in a shop run under the methods being described. With all factors under control a radical change in the shop schedule can be made, and is continually being made, without serious handicap to the general efficiency of the shop.

When shop schedules are under control, the customer is able to work to a closer schedule himself than if he had to make larger allowances for failure on the part of the foundry to meet its shipping promises. The result of this condition is to reduce to a minimum the change of schedule on the part of the customer. His confidence in his source of supply materially helps both parties. He also reaps material benefit in dollars and cents due to less capital invested in work in process of being manufactured.

The preliminary work necessary to get a job under way must be given careful attention and vigorously followed up. The proper preparation of pattern equipment, including its rigging up makes an enormous difference in the delay (and hence the cost) of getting a new pattern up to maximum production. The planning of the preparatory work and the making of the first few samples often requires the combined knowledge of all the factory board. This part of the schedule is the most difficult one to intelligently plan and bring through on time. This is the part of the work that gives the order-of-work clerk the most trouble. It is also the part on which he must rely in a large measure on the assistance of others, especially the pattern foreman and equipment boss.

At times the shop schedule has to be planned after the above mentioned preliminaries are worked out. This is especially true in cases where the equipment is furnished wholly (or in part) by the customer. At any event, the correct preparation of a job may be considered as the one greatest step toward its successful completion. The control of the subsequent shop operations is comparatively simple.

(To be continued)

Coke Recovered from the Cupola Dump

By W J Keep

IT IS common practice among foundrymen to take the half-burned coke from the cupola drop and to let the man on the charging platform use it as he pleases without weighing. As it is water-soaked the weight would not be correct and as it has been weighed once, it should not again be charged against the cupola fuel consumption. It is desirable, of course, to charge no more iron and coke than is necessary to make the last iron good. At best, considerable iron will remain unmelted or will be cast in the pig bed. A corresponding amount of coke will be left over, but much of this fuel is burned by the sharp blast and hot cupola at the end of the heat. The best practice is to decrease the coke on the last three charges and frequently the last charge of iron can be melted without the addition of coke, the heat in the cupola walls being sufficient to melt the iron. The coke left over is not considered of much value and it certainly does not seem to have much fuel value.

In the production of a certain grade of iron, it was found desirable to have the sulphur run as low as possible and the cars of coke containing exceptionally low sulphur were saved for that purpose. When we previously used Connellsville coke it was considered desirable to have the ash content about 10 per cent so that the coke would satisfactorily carry the weight of the burden. Rarely was the sulphur less than 0.75 per cent and frequently it was 1 per cent or more. The by-product coke which we are now using has a firm structure and a low percentage of ash. One morning it occurred to me that the burned coke should be high in ash and low in sulphur and if so, it should be charged on the bed. I took samples of by-product coke from the car from which the half-burned coke was taken and sent it to the producer to obtain the opinion of his chemist to ascertain the analyses of both the burned and the unburned coke.

He reported that the partially-burned coke is higher in ash than the average coke and for that reason would not be quite so good for melting iron. On the other hand, it is lower in sulphur than the unburned coke and for this reason it would be more desirable for melting iron than fresh coke. Apparently the sulphur is imparted to the iron in a gaseous state and not from the molten or slag state. If the burning coke is not disturbed, the coke holds its original shape fairly well, retaining the ash as the carbon burns out, but in a cupola, the chemist ventured the opinion that the burden and the movement downward would have a tendency to separate the ash somewhat from the coke during burning.

The report of the chemist follows: A sample of coke was obtained from the ovens containing 7.40 per cent ash and 0.902 per cent sulphur. Several pieces of this coke, about nutmeg size, were weighed, placed in a platinum dish and heated in a muffle about 1½ hours. Nearly two-thirds by weight of the coke was consumed, the volume remaining nearly the same and very little of the ash fell off while the coke burned, if it remained undisturbed. The unburned portion of the partly burned coke contained 8.86 per cent ash and 0.706 per cent sulphur. The ash from the burned coke contained 0.152 per cent. The weight of the pieces taken was 20.4419 grams, the amount burned off was

13.2741 grams and the unburned coke left weighed 7.1678 grams. The ash balance follows:

Grams of ash in coke at start.....		1.5127
Grams of ash in unburned coke.....	0.6351	
Grams of ash actually burned part.....	0.8764	1.5115
Unaccounted for.....		0.0012

Sulphur Balance

Grams sulphur in coke at start.....		0.1844
Grams sulphur in unburned coke.....	0.0506	
Grams sulphur in ash...	0.0013	0.0519
Grams sulphur gone off in gas (by diff.).....		0.1325

0.1338 gram (0.1844—0.0506) of sulphur left the coke.

Of this 99.03 per cent went off in gas while only 0.97 per cent remained in the ash.

Another sample of coke was obtained containing ash, 6.96 per cent, and sulphur, 0.759 per cent. Several pieces of this coke were placed on a fireclay cylinder standing upright. The coke rested on a screen, being heated by a blast lamp burning full blast for 1½ hours. The results obtained were similar to those in the first test, although in this case some of the ash was disturbed in the coke by the blast. The unburned coke contained 9.12 per cent ash and 0.686 per cent sulphur. The ash from the burned coke contained 0.135 per cent sulphur. Several other pieces of the coke were heated in the cylinder by a blast lamp for 2¼ hours and in this case the unburned coke contains ash, 9.72 per cent and sulphur, 0.657 per cent. This shows a still greater increase in the ash and a corresponding decrease in the sulphur.

From these tests it is apparent that when coke in only partially burned, the unburned portion is higher in ash and lower in sulphur than the original coke. The ash will not fall off while the coke burns if undisturbed. Only 1 per cent of the sulphur in the coke remains in the ash, the rest passing off in gas. Whether any of this sulphur is absorbed by the iron and if so, what amount, can best be determined by work on a cupola in actual operation. However, if iron melted in a cupola increased in sulphur, it certainly must have taken it up from the coke, the limestone or from some other part of the charge.

Michigan Stove Co. Samples

The samples of coke received from the Michigan Stove Co. analyzed as follows:

Fresh coke—Moisture, 0.12 per cent; volatile matter, 0.77 per cent; fixed carbon, 91.43 per cent; ash, 7.68 per cent, and sulphur, 0.582 per cent.

Burned coke—Moisture, 0.15 per cent; fixed carbon, 91.07 per cent; ash, 8.78 per cent, and sulphur, 0.527 per cent.

Limestone nearly always contains some sulphur and this may have considerable bearing on the iron. The chemist ventured the opinion that it does so because much of the sulphur of the coke passes off in the gas in the form of sulphuric acid (SO_3), while the sulphur in the limestone present as $CaSO_4$ would probably be partly at any rate, if not entirely, reduced to CaS, which being non-volatile, would tend to come in contact with the molten iron and give up its sulphur to it.

The Ingersoll-Rand Co., New York, has issued a number of new bulletins. An attractive 36 page booklet describing pneumatic drills for both metal and wood boring has been published, together with a 12-page bulletin on pneumatic shipping, calking and scaling hammers, and an 8-page pamphlet on the air hoist for miners and contractors which was described in *The Iron Trade Review* recently.

Making a Herringbone Grate Pattern

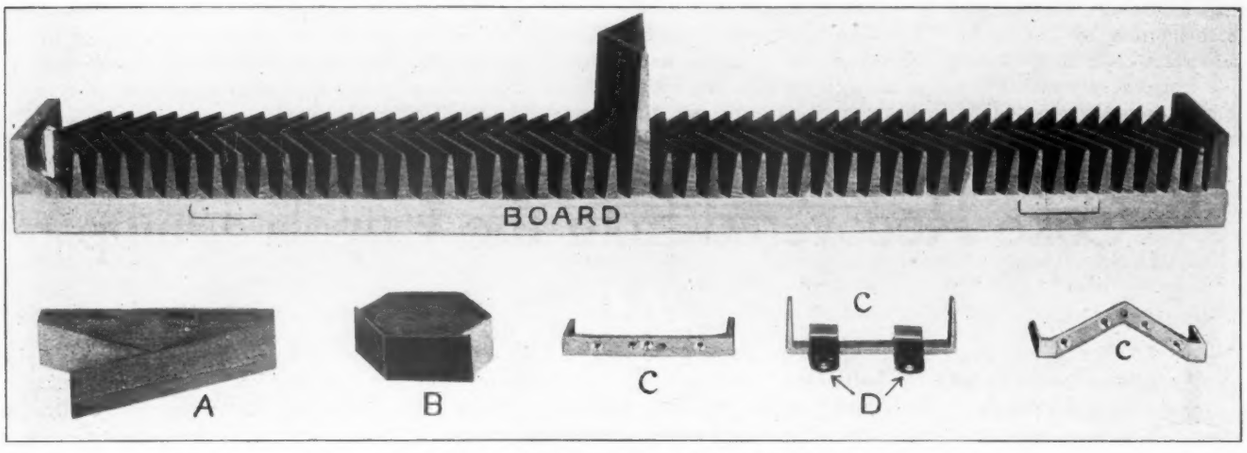
By J. L. Gard

An economical method of making a herringbone grate pattern is shown in the accompanying illustration. After 700 castings had been made from the pattern, the joints were still in good condition. The bars were sawed out on a buzz saw with the gage tilted so that two bars were cut from a single piece of lumber. This also saved planing. The sides of the pattern, which are not shown in the illustration, were made of quarter sawed stock so that they would show as little tendency to warp as possible. The block *A* was used as a guide on the buzz saw to cut off the ends of the cross bars to the proper angle and length and it was also used on the trimmer to cut the ends properly for a glue point.

The bars were glued together on the form shown at *B*, both sides of which were used. One piece was allowed to set while the other side was being used to glue another bar. The joint at the apex of the bar was nailed and screwed after the glue had set. Each bar was then sandpapered and covered with two coats of varnish.

While the varnish was drying, the bottom board was prepared and the position of the cross bars was carefully laid out on it. The center and end bars were glued and screwed through the board and the small cross bars were glued firmly in place according to the lay-out. After the glue had set firmly, which in this case happened to be over night, all of the ends of the cross bars were sawed off nearly even with the edge of the bottom board, which had been planed to the proper angle. The ends of the cross bars were then planed off flush with the board. This made it possible to get perfect joints between the bars and the sides of the pattern. The small cross bars were

(*Continued on page* 452)



BUILT UP HERRINGBONE GRATE PATTERN

How to Estimate Selling Prices of Castings

Report of an Investigation Made to Ascertain the Practice of American Foundrymen in Making Quotations on Their Product

By A O Backert

TO ascertain the methods pursued by foundrymen in estimating the selling price of castngs, an investigation was conducted, in the course of which 1,000 letters were mailed to all of the members of the American Foundrymen's Association and leading jobbing foundries of the United States. A series of 11 questions was asked and a total of 109 replies was received. It frequently has been stated that the number of foundrymen who make careful estimates on work is not large, yet the bulk of the replies received indicates that an earnest effort is being made to quote intelligently on new work. It cannot be denied that the practice of guessing at the selling price of castings is still too prevalent for comfort and it is hoped that some standard system of estimating will be evolved which can be followed by foundrymen generally. The questions submitted follow:

1.—How do you determine the selling price of your castings?

2.—Do you employ an estimator to compute the selling price?

3.—Do you follow any special rule or formula in preparing an estimate?

4.—What ratio does your overhead expense bear to your labor cost?

5.—What do you include in your overhead expense?

6.—In making an estimate, what allowance do you figure for contingencies such as haulage, special rigging, pattern repairs, rejections, etc.?

7.—What percentage of profit do you estimate on each job?

8.—Does the estimated percentage of profit vary on heavy and light work?

9.—How do you estimate labor cost on a job and what do you include in this estimated cost?

10.—How do you estimate the cost of molten metal in the ladle?

11.—Do you base your estimates on data previously obtained from your cost system?

It was surprising to note that practically one-half of the foundries employed estimators and operate estimating departments, while a number delegate this work to one of the plant executives. Only one empirical formula was reported for estimating the selling price of new work. Many foundrymen are averse to accepting formulas at their value, believing them to be the obscure symbols of the abstruse science. However, in several well-managed shops a similarity of formulas has been found, which would indicate that the adoption of a universal system would not involve many difficulties. This formula used by several foundrymen, follows:

$$W + L + 1\tfrac{1}{2}\ L + C + P = \text{the selling price.}$$

W represents the weight of the casting multiplied by the cost of the metal in the ladle to give the cost of the metal in casting; L represents all labor, including molding, coremaking, melting, shipping, etc., and 1½ L represents the overhead charges; C represents contingencies and includes casting losses, haulage, special rigging, pattern repairs, etc., and P represents the profit.

The ratio of overhead expenses to direct labor cost was found to vary considerably and as high as 3:1 was reported. Numerous interesting replies also were received in answer to the question regarding percentage of profit estimated and in most cases competition governed this entirely. With few exceptions, all the foundrymen answering the questions submitted reports that they based their estimates on data previously obtained from their cost system. This would indicate that an earnest effort is being made to arrive at accurate costs, but evidently the systems in use are inadequate or they are improperly applied.

In the following an effort has been made to summarize the replies as far as possible, although the wide variance in the nature of the answers made it almost an impossible task to properly classify them:

How do You Estimate the Selling Price of Castings?—The purpose of this inquiry was to ascertain what methods are pursued in fixing the selling price of the foundry product. In a measure, the inquiry was somewhat broad, nevertheless the replies received indicate a wide variance of methods and the need for the establishment of some standard system for making estimates on new work. The following briefly compiles some of the replies:

Nine foundries replied that they made their estimates by the records of the cost of similar work; five determined the selling price by actual cost and add the profit; three estimate the selling price by the cost of molding, iron and overhead, to which the profit is added; one foundry fixes the selling price by estimating the cost of producing on the basis of daily output in pounds per molder; another replied that the price is fixed by the amount of labor expended, materials used, overhead charges, cost of changing flasks and special rigging; one replied "What we can get and by experience"; by figuring each job separately, one reply; three replied "Make close estimate on anticipated cost and add percentage of profit, which varies with the kind of casting;" judgment of estimator and basis of cost records, one; selling price based on American Foundrymen's Association standard cost system, one; by cost and what we can get, four; based on price of pig iron, one; value of molten metal at the spout, plus the direct labor cost and a profit of 8 to 20 per cent, one; estimate molding and core labor, to which is added overhead, cost of molten iron and selling expense, 15; two concerns that do repair work for railroad and mills, respectively, replied that the price is governed solely by local competition and that a uniform price for both light and heavy castings for the entire year is made; by estimating cost and percentage of profit, seven; cost of molding, overhead, 5 per cent for loss and defectives, 25 per cent for loss in blowing and 20 per cent net profit, reply from a side-blow converter plant; by taking average cost of several melts, one; total of all materials, labor, overhead and 25 per cent profit, one; direct labor plus melted metal plus indirect cost plus overhead and profit, two; don't estimate if we can avoid it, take a few castings on trial, figure molding cost and make price for long run, one; price based on cost of molding, one; price based on direct labor, one; by actual cost of each pattern, one.

Do You Employ an Estimator to Compute the Selling Price? — Many of the most progressive shops employ special estimators who are trained to fix the selling price of castings from blue prints, patterns, etc. This is a specialty that has developed in recent years and it is unfortunate that estimators are not employed more generally. A total of 43 foundries replied that they employ estimators; 39 are without estimators and a special estimating department; seven delegate this work to the cost department and three to the sales department. In addition, a number of foundries replied that the estimates are made by the superintendent or manager with the co-operation and aid of the foundry and pattern shop foreman.

Presented at the Chicago meeting of the American Foundrymen's Association.

Do You Follow Any Special Rule or Formula in Preparing an Estimate? —The purpose of this question was to ascertain whether any empirical formula is employed, which in a simple manner and by symbols would contain all of the charges necessary in estimating a selling price. Fifty-five foundries replied that they follow a special rule, but in most instances no formula is employed. Forty-three replied that no special rule or formula is followed. One formula submitted follows:

$$P = \frac{2.14\ M + W\ (F + 1)}{W}$$

P = cost per pound.
M = the molding cost.
F = the cost of melting.
I = cost of iron including shrinkage and
W = the weight.

The overhead is included in the molding cost charge which is figured at 214 per cent, making the overhead 114 per cent of the labor cost.

What Ratio Does Your Overhead Expense Bear to Your Labor Cost? —Of all of the questions submitted, none is of greater interest to foundrymen and the wide variance in the ratio indicates the source of low quotations on castings and the reason for the large number of failures recorded annually in the foundry industry. While the ratio was asked for, many of the replies were in per cent. It is surprising that this ratio varied from 1/10:1 to 3:1, although one foundry reported a ratio of 6:1, which evidently is an error. With a normal production a ratio of 1.5:1 is generally accepted as a safe margin for overhead to labor cost, although when production decreases overhead automatically increases. This is a feature overlooked by many foundrymen and in place of increasing their overhead per pound of output when production declines, prices usually are reduced and losses necessarily must be incurred.

The following briefly notes the variety of replies received and the difference in this ratio as reported by various foundrymen:

Two hundred per cent on actual wages paid molders; 100 per cent on wages paid coremakers and where special cleaning is required 100 per cent is added to cleaners' time in the cleaning room; differs materially with class of castings made; ratio of overhead to productive labor cost, 300 per cent; 142 per cent of net productive labor in 1913; add 125 per cent to direct labor and 19½ per cent to total cost for selling; normally 150 to 175 per cent according to business conditions and melt; light castings 50 per cent and heavy castings 34 per cent; foundry 65 per cent and office 25 per cent, making a total of 90 per cent; average 1913, 220 per cent; average for five years 114 per cent; molders' overhead 150 per cent, which includes cost of cleaning and coremakers and 100 per cent includes cost of material for cores; about 16 per cent, the salaries of the management being included in the labor cost and the salaries of the officials in overhead; 18 to 30 per cent per productive hour; overhead varies on each job; varies on different operations as overhead is divided up and included in the burden for each operation; 100 to 150 per cent on molding labor; foundry overhead 45 per cent and general overhead 45 per cent; depends on what percentage of our capacity we are operating, running 40 per cent capacity the overhead is 50 per cent or more of our total labor cost; ratio of overhead to labor cost was 214 per cent during the last three months and this varies every day throughout the year. In addition to the foregoing numerous replies were received with estimates from 10 to 300 per cent. A number of these follow: 10, 20, 33 1/3, 43, 50, 85, 90, 100, 142, 172.4, 220 and 300 per cent.

What do You Include in Your Overhead Expenses? — The purpose of this question was to ascertain what fixed charges were included in the overhead and with few exceptions most of the foundrymen endeavor to include all charges that cannot be classed as labor, material, etc. One foundry replied that all factory expenses, including depreciation and factory supervision other than productive labor and material, were classed as overhead expenses, but minor materials such as core sand, etc., are not passed through the stores, but are charged as an expense and are included in the overhead. A few of the replies received follow:

Melting, fuel, supplies, repairs to equipment, cupola labor, salaries, errors, laboratory expense, but this does not include the interest, depreciation and general superintendence of the plant; executive's salaries, clerk hire, insurance, rent and taxes, traveling expenses, teaming, etc.; interest, depreciation, advertising, rent and repairs to equipment; all expenses except wages of molders and coremakers; all supplies, maintenance expenses, etc., and all labor except direct productive labor, but general office expense, including salaries, insurance, taxes, selling expenses, etc., are figured as a percentage of direct labor cost and are added to this item; insurance, taxes, interest, legal expense, salaries, office expense, general expense, repairs, defective loss, shipping, yard force, superintendent and clerical help, accidents, laboratory, advertising, commission and traveling; everything except raw material and direct labor is charged in the overhead; salaries, expense of building, freight and teaming, office expenses, insurance, interest, general expense, expenses of small tools, stable, machinery and fixtures, traveling, advertising, supplies, lighting, royalties, power, taxes, legal expense and 5 per cent depreciation on machinery and fixtures, real estate and stable inventory; all charges that cannot be applied to any specific order; helpers, blower expense, machinery depreciation, insurance, taxes, heat, light, power, small tools and supplies, proportion of pattern costs, casting cleaning and proportion of office expense; miscellaneous labor, miscellaneous supplies, expense on rejected castings, heat, light, power, insurance, depreciation on plant and equipment and superintendence; depreciation on everything entering into cost of manufacture except direct labor, indirect labor, materials directly entering into product and incidentals which are directly connected with any manufacturing operation; all expenses of every kind except productive labor; fuel, fire brick, clay, sand, repairing tools and machinery, general repairs, general expense, teaming, oils, electric light, taxes, power, miscellaneous supplies, all foundry labor except molding and coremaking, general office expenses and accident liabilty.

The foregoing indicate that an earnest effort is being made by foundrymen generally to arrive at their overhead expenses, although it is evident that various methods are pursued and undoubtedly cost experts could point out many errors in the apportionment of the overhead expenses.

In Making an Estimate What Allowance do You Figure for Contingencies, Such as Haulage, Special Rigging, Pattern Repairs, Rejections, Etc.? — Only too frequently many of these items are overlooked in estimating the price of selling castings and unforeseen contingencies frequently arise which result in losses being incurred. One foundryman states that his product covers a range of material from castings weighing three tons each to rough, light hardware, so that allowances for contingencies, etc., must be based on practical experience and are different in every case. He added that on the accurate gaging of these expenses the success of most foundrymen depends and he considers this one of the most important items in estimating the selling price. Another foundryman replied that these items enter directly into manufacturing expenses or overhead, with the exception of rejections. As he is engaged in the automobile cylinder castings business, the rejections are higher than normal, which are included in the defective casting record and are charged after the overhead is computed. In another instance no allowance is made for any of these items unless new patterns or special rigging is required, in which case the actual cost is borne by the customer if a small order, and is absorbed either wholly or in part by the foundry in the case of a large order. Other replies briefly are as follows:

Make no allowance but make the price high enough to include any special hauling required; in making an estimate we approximate as closely as possible the actual cost to us of haulage, special rigging, etc.; no special rule, when competition is keen, the margin is close; items included in overhead generally, but we take into account the cost of special rigging and in the case of especially difficult and intricate work we make additions to cover the extra cost and liability of rejection; it differs on each job according to the class of work; covered in overhead expenses; 10 to 20

per cent; included in the overhead, 2 to 12 per cent; 7 per cent on hand molding and 15 per cent on machine molding; all included in overhead except rejections, which are figured by percentage according to the individual job; no contingencies are figured for hauling, special rigging and pattern repairs and if such are needed, the costs are figured in the estimate; the amount allowed for rejections depends entirely on the class of castings and is usually estimated by the superintendent; make special allowance for each item; pattern repairs are charged to customers and a certain percentage is added to every estimate for rejections, the amount depending on the class of work; where special rigging is necessary, the actual cost of labor and material is charged to the job, while haulage and other contingencies are included in our overhead; special rigging, haulage and pattern repairs are included in foundry overhead expenses; 40 per cent; 5 per cent; 25 per cent is added to cost of labor and materials; about 3 per cent of direct labor for special rigging and pattern repairs and an average of 18 per cent for rejections; carried in allowance for profit; estimate contingencies as closely as possible, based largely on previous experience; special rigging is added to the estimate, but other contingencies are taken care of by the burden; inward cartage is charged to the cost of materials, outward cartage is a sales expense and is charged to the same and we accept only long runs of work, rejecting all short runs requiring special rigging.

Pattern repairs other than sandpapering or shellacing are charged to the customer, while rejections vary, but should not exceed 2 per cent after the goods have left our hands; freight and pattern repairs generally are charged direct to the customer at cost; we add $1 per ton for hauling and usually 2½ per cent for special rigging; haulage is charged direct to material which shows up in the pound price of material; shipping is charged direct into a separate sub-division showing up in the pound price; special rigging is charged in a sub-division to the job order on which it is used; pattern repairs are charged into repairs pattern sub-division; rejections from the foundry are covered by a foundry scrap percentage and from customers into an account known as "customer scrap."

What Percentage of Profit do You Estimate on Each Job?—This proved to be an exceedingly difficult question for most foundrymen to answer owing to the fact that competition to a large extent governs the amount of profit that can be obtained. One foundryman stated that he endeavors to obtain 20 per cent, but frequently he found competitive conditions such that a larger profit could be obtained on some jobs while on others the profit had to be greatly reduced. Based on figures of his annual business, he found that the profits varied from nothing at all, or even a pretty stiff loss to 25 per cent during an exceptionally good year. Another foundryman stated that he does not estimate any particular percentage of profit on each job since the overhead figures are on the safe side to the extent of from 3 to 5 per cent, and then is estimated a profit varying from 5 to 15 per cent, depending upon what the job is supposed to carry. One foundryman operating a large plant in the west replied that he has what is known as a critical output below which he cannot cover overhead expenses and up to this critical output business will be taken at cost rather than turn it down. Above this critical output from 10 to 30 per cent profit is figured, according to the size of the job and the state of the market. Another foundry engaged principally in the production of heavy work figures a fixed amount of profit for each molder's daily output, repardless of what it is. The majority of the replies indicates that the foundrymen endeavor to obtain a profit varying from 5 to 50 per cent and a fair average would be 20 per cent. Also the practice varies in figuring the profit for light and heavy work. However, many of the replies point out that while profits are figured, nevertheless in the stress of competition they frequently are entirely overlooked.

Does the Estimated Percentage of Profit Vary on Heavy and Light Work?—Opinions differ widely on the percentage of profit that should be figured for light and heavy work. One foundryman states that it should vary and points out that most foundrymen consider heavy work the most profitable. This he claims is a fallacy as there is no reason why light work with modern methods should not be just as profitable as heavy. However, another foundryman states that one general percentage of profit should be figured for all work.

While there is no uniformity in the practice of estimating the percentage of profit on heavy and light work, the majority of replies point out that the profit varies, the larger profit being figured for heavy work and a smaller profit on light work. On the other hand, several foundrymen insist that the same percentage of profit should apply on both light and heavy work. While some foundrymen estimate a larger profit on heavy work, others demand an increased profit for light work and the replies indicate no uniform practice among foundrymen in estimating the profit on castings of varying weights. This is a feature of selling price estimating that should receive the careful attention of the cost committee of our association.

How do You Estimate the Labor Cost on a Job and What do You Include in This Estimated Cost?—One of the unknown quantities in estimating the price for new work is labor cost and the replies indicate that this cost is estimated largely by experience and past performances on similar work. The majority of the replies pointed out the method of estimating the labor cost after the job has gone through the foundry, but this information was not sought. One foundryman stated that his estimate of labor cost on a job is obtained from the foreman and superintendent, who figure on the number of hours it will take to do the work and an effort is made to be on the safe side. In this estimate are included the cost of coremaking, helping and molding and this generally is figured in cents per pound and is added to the other charges. After the job is completed a rough estimate is made to see how closely he approximated the original figures and in time this will give a fairly accurate idea of how close these figures are being made. Another foundry replied that the labor cost is estimated by comparing the job with similar jobs previously turned out. In one shop the labor cost is estimated by the foreman after consultation with his assistants and includes the actual labor of molders' and helpers' time only, being figured at a rate which includes the time spent in pouring. For example, a man to whom $3 per day is paid would be figured at the rate of 40 cents per hour for actual molding time. In another shop the labor costs on all jobs are estimated from piecework rates furnished by the superintendent of the foundry made up by him covering the jobs. The molding, cleaning and machining, core and annealing costs are included in these labor figures. The interesting practice in one shop is to determine the amount of time required and to double it to cover overhead expenses.

How do You Estimate the Cost of Molten Metal in the Ladle?—Estimating the cost of the molten metal individually is a practice not pursued by many foundrymen, although one explained his method in great detail as follows: "We go on the assumption that the molten metal is delivered into the ladle as though it came from some outside shop. This cost includes the cost of the metal in the yard on the basis of the particular charge being used at that time and to this is added a general average coke charge based on the yearly purchase of coke on the basis of the coke ratio, and to be on the safe side, we figure about 5:1, although our cupola practice is better than this. We figure lining on the basis of the material required during the year for this work and then figure the power required to operate the cupola, adding floor, elevator and all labor in connection with handling iron and attendance during melting. We figure a depreciation charge and repairs actually based on the value of the apparatus for doing the melting, which is

aside from the general depreciation in the rest of the shop. The loss is figured on the results of many experiments and includes loss of metal through slagging, spills, etc. Another loss is added to cover the difference in the value of the metal going into the cupola and the scrap made in the shop and this is charged against the cost of melting. All of these items are added and divided by the average tonnage from which the general cost is established."

The replies indicate that the majority of the foundries have fairly accurate methods of obtaining the cost of the iron in the ladle, although in several instances merely the cost of the iron, scrap and fuel are considered, no allowance being made for melting losses, etc.

Do You Base Your Estimates on Data Previously Obtained From Your Cost System?—This inquiry was made for the purpose of ascertaining to what extent foundrymen have installed cost systems and with only few exceptions, they replied that the estimates were based on such data.

The foregoing indicates that foundrymen generally realize the necessity of making proper estimates, yet the absence of some standard system or formula makes it practically impossible for any two foundrymen to arrive at approximately the same quotation of new work. It is apparent also that estimating schools established by several trades would prove of value to foundrymen generally and the consideration of such a move is earnestly urged upon the cost committee of our association. Furthermore, the time available for the consideration of these replies made it practically impossible to summarize the large amount of valuable information that can be obtained from them. It is suggested that the cost committee pursue this investigation further with a view of establishing a standard formula for estimating the selling price of the foundry output.

Making a Herringbone Grate Pattern

(*Continued from page* 448)

stuck to the sides with thick shellac, but the center and end bars were glued. Glue was not used on the small bars because it could not be put on fast enough and also because molding sand does not stick to shellac in small openings as it does to glue.

After the sides had been glued in place, screws were put into the middle and end bars, and cabinet clamps were placed over the pattern to hold the small bars in contact with the sides while they were drying. After the pattern was dry, each cross bar was fastened with a screw and a nail through the side. After the sides were securely fastened, they were cut off and planed on top.

The sides of the pattern finally were tied together by the brass castings shown at *C* in the illustration and draw straps *D* were put on each end.

Removing Sulphur With Manganese

By C. L. Ach

In the August issue of THE FOUNDRY, page 289, W. J. Keep makes the following statement: "Sulphur up to 0.11 per cent has little influence on the hardness of the casting if the iron is melted hot. The damage is done during the process of melting by sulphur which is not left for the chemist to find".

I would like to take issue with Mr. Keep on this, since metallic iron will absorb all the sulphur coming in contact with it up to 36.5 per cent (as in the compound, FeS), and holds it tenaciously. The only elements that are proposed in practice for the removal of sulphur from cast iron are calcium in the form of lime and manganese in the form of ferro-manganese. We know that an element such as aluminum, which decomposes dissolved iron oxide and thus prevents the formation of the gas, carbon dioxide, in the metal, is an advantage in that something actually occurs. I cannot, however, agree with the statement that the "Sulphur which is not left is what does the damage", (and which we are striving to force to the top of the stack or out of the slag hole). If the sulphur which passes out does the damage, it stands to reason that it is advisable to endeavor to hold the sulphur in the iron and perhaps even add more. Mr. Keep also states "A dose of medicine may do wonders to a human being, but after it has passed through his system a chemist might find no trace of the cause by analysis of any part of his anatomy". Sulphur in iron works the same "wonders" as cyanide in a human being and is about equally as difficult to remove.

Loss of Weight in Annealing Malleable Iron

By W. J. Keep

Question:—In the June, 1914, issue of THE FOUNDRY an article was published in which it was stated that malleable iron loses about 1 per cent in weight as a result of the annealing process. In the shop in which I am employed we anneal castings of various sizes and shapes and in most cases we succeed in holding the weight. Perhaps the loss referred to was caused by scaling.

Answer:—The question answered in the June issue of THE FOUNDRY was in reply to an inquiry as to whether castings lose or gain weight as a result of proper annealing. This is a difficult question to answer, because all castings that are not tumbled or sand-blasted before annealing have more or less sand scale adhering to them, which falls off in the annealing process, but this cannot be considered scaling. There is no doubt but that some of the carbon is removed and from some work that is well cleaned more or less of the sand likewise is removed. Even with the most careful packing and luting of the pots there is some oxidation. There should be some loss. The weighing of castings in foundries, as a rule, also is a very uncertain process. Laboratory experiments on the other hand generally have shown a loss in the weight of castings after annealing. Several years' run at a large malleable iron foundry shows a loss in weight of castings made, of about 1 per cent. To show a gain would raise the question of accuracy in weighing and cleaning.

Charge for a 28-Inch Cupola

By W. J. Keep

Question:—Our cupola is lined to 28 inches, but we would like to take off a heat of about one ton for small castings, which must be close-grained, soft and easily machinable. What kind of a mixture should be used, and we would like to know what grade of pig iron should be employed, the amount of fuel and the metal to be used on each one of the charges.

Answer:—I happen to be using a 28-inch cupola and will give you the record, although you will be able to obtain a better fuel ratio, as you will not have to have the iron as hot as we use it. The tuyeres in this cupola are 10 inches from the sand bottom, six of these being installed, each 3 inches high and 10 inches wide. The blast pressure is 7 ounces. Three hundred and fifty pounds of coke are charged on the wood fire, which is lighted at about 11:30 a. m. and care is exercised to prevent the fire from burning too fast. At 2 p. m. we charge 100 pounds of coke and 320 pounds of iron. We follow this with five more charges of 50 pounds of coke each and 320 pounds of iron, which fill the cupola and the blast is put on 2:15 p. m. Iron is down 15 minutes later. We melt 14 charges and tap the slag as soon as it will run. On each charge two heaping handfuls of limestone are placed. Frequently no coke is added for the last charge. The bottom is dropped at 3:30 p. m. for soft iron. The silicon should be 2.75 per cent and if you have good coke and good scrap, you can use 50 per cent scrap and any good grade of foundry pig iron. The more scrap you use the closer will be the grain.

Effect of Heating on the Properties of Bronze

Results of an Interesting Series of Tests to Ascertain the Effects of Heating on Various Bronze Mixtures

TO ASCERTAIN the effect upon the physical properties of bronze by heating to various temperatures up to 700 degrees Fahr. an interesting series of tests was conducted by John Dewrance, the results of which were presented at a recent meeting of the Institute of Metals. In presenting the subject the author pointed out that the dictionary meaning of the word *bronze* is a compound or alloy of from 2 to 20 parts of copper to 1 of tin, to which other metallic substances are sometimes added, especially zinc. In times past, the gradually increasing additions of zinc and lead discredited the name of bronze. In the manufacture of guns, it was found that the best results were obtained by an alloy of 9 parts of copper and 1 part of tin. This became the standard material for the manufacture of guns for many years.

Gun Metal

To distinguish this alloy from the inferior mixtures that had previously been supplied under the name of bronze, the designation *gun metal* was introduced. As time went on the new name gun metal was no more respected that the old one of bronze, and at the present time any alloy that does not come under the description of pot metal or brass is called gun metal. As guns are now universally made of steel, it seems desirable to return to the dictionary description and to call all alloys, mainly composed of copper and tin, *bronze*.

To the previously mentioned alloy of 90 per cent copper and 10 per cent tin, it is very largely the practice to add 2 per cent of zinc, making 88 per cent copper, 10 per cent tin and 2 per cent zinc. When tested at atmospheric temperature this alloy gives excellent results. As a great deal of bronze is used at the temperature of high pressure steam it becomes important to investigate its behavior at temperatures that correspond.

How the Tests are Made

The tests, the results of which are given in Figs. 1 to 4, were conducted for the author by R. H. Harry Stanger. The heating apparatus was an air-tight tube boiler heated by gas from a ring burner. The specimen was held in screwed jaws in the center, both end jaws being insulated, and the boiler was also coated with asbestos.

The testing machine was a 50-ton, vertical, Buckton, the weight of the apparatus having been carried on the bottom headstock; the top end of the specimen was held in a plunger which entered the top of the heating apparatus through a broad guide with a sliding fit. Both ends of the apparatus were held in the headstocks by means

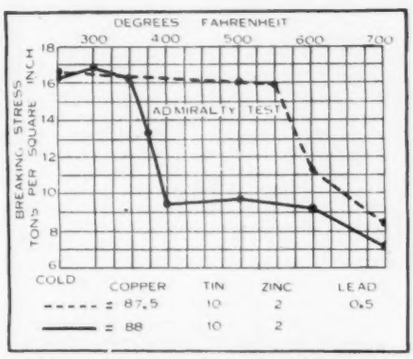


FIG. 1—CHART SHOWING BREAKING STRESS OF ALLOYS

of spherical holders, which allowed the whole to find its true vertical axis.

As the specimen was entirely enclosed during the test, some outside means had to be adopted for ascertaining the yield point, if any; the two ends of the heating apparatus were connected to a Wickstead hydrographic recorder.

Taking the Temperature

An experimental specimen was drilled with holes in different positions along the parallel length, and the bulb of a thermometer was inserted in the various positions.

This thermometer was found to agree very closely with another thermometer that recorded the temperature in the air chamber, and, therefore, it was inferred that the readings of the thermometer in the air-chamber gave correct readings of the temperature of the specimen.

The percentages of elongation were given by the Wickstead recorder and are stated throughout as the percentage on 2 inches.

The copper employed in these tests was that which is known on the market as "Best Selected", and has the following average analysis:

	Per cent.
Copper	99.55
Nickel	0.01
Arsenic	0.026
Lead	0.08
Bismuth	0.004

The tin and zinc were the best commercial quality.

First Tests

In the first tests made 88 parts of copper were melted in a new crucible, 2 of zinc were added as soon as the copper was melted and allowed a short time to flux the metal, 10 of tin were then added, the whole mass stirred and the test-pieces poured at as near the same heat as could be judged by a careful molder.

The black line in Fig. 1 shows that at atmospheric temperature the 88 copper, 10 tin and 2 zinc alloy has a maximum stress of 16.35 tons per square inch, and the black line in Fig. 2 shows an elongation of 11 per cent in 2 inches.

At 400 degrees Fahr. it has a maximum stress of 9.5 tons, and an elongation of only 1 per cent.

At 700 degrees it has a maximum stress of 7 tons and elongation of 0.25 per cent.

The first series of tests undertaken covered the range between 400 and 700 degrees Fahr., and the results were so unexpected that it was considered advisable to retest some of the broken samples in the cold state, to ascertain if the fault was in the casting of the test pieces.

For this purpose samples which had failed at 400 and 500 degrees Fahr. were turned down and suitably mounted, and when re-tested at atmospheric temperature gave a breaking stress near 18 tons per square inch. Further samples in this same mixture were then prepared and tested at temperatures between atmospheric and 400 degrees Fahr., and the results plotted in Fig. 1 show very clearly that the metal begins to lose its strength above 350 degrees Fahr.

Additional Tests

In the next tests made 87½ parts of copper were melted in a new crucible, 2 of zinc were added as soon as the copper was melted and allowed a short time to flux the metal; 10 of

tin and ½ of lead were then added together and the whole mass stirred. It will be observed that the only difference between this and the previous experiments is the addition of ½ per cent of lead at the expense of the copper.

The dotted line in Fig. 1 shows that at the atmospheric temperature the maximum stress is 16.5 tons per square inch, and the dotted line in Fig. 2 shows the elongation to be 8 per cent.

At 550 degrees Fahr. it has a maximum stress of 15.8 tons and elongation of 18 per cent.

At 700 degrees it has a maximum stress of 8.25 tons, and an elongation of 2 per cent.

The breaking stress of 11.25 tons per square inch at 600 degrees Fahr. is an average. No actual sample broke at this stress. It was found that some samples tested at this temperature gave results of approximately 16 tons per square inch, and others 7 tons per square inch. From this it may be concluded that 600 degrees is the critical temperature of this alloy.

Previous Tests

In a paper read before the International Association for Testing Materials at the sixth congress in New York, 1912, by J. M. Bregowsky and L. W. Spring, of the laboratory of the Crane Co., Chicago, the results are given of tests, among others, of a material called U. S. Navy gun bronze G, which has a composition of 87.6 per cent copper, 10.4 per cent tin, 1.31 per cent zinc and 0.39 per cent lead; it also is stated that it sustains 0.11 per cent iron, but it is probable that the iron content given is due to using a file for preparing the sample for analysis, as such an alloy ought not to contain such a proportion of iron.

The chart of the test of this metal at first sight appears inconsistent with the results given in this paper; but this is due to the fact that the tests made were not sufficiently numerous. The first test appears to be at about 80 degrees Fahr., and gives a maximum stress of 15 tons and elongation of 9 per cent; the second test is at 300 degrees Fahr., and gives a slightly increased maximum stress of 16½ tons and elongagation of 9.5 per cent. The next test is at 450 degrees Fahr. and gives a maximum stress of 14.75 tons and elongation of 8 per cent. There is not another test until 600 degrees Fahr. at which temperature the maximum stress is given at 10 tons and the elongation as 4 per cent.

As previously stated, 600 degrees Fahr., is the critical point, and it is unfortunate that there is such a wide gap of temperature between this test and the previous ones, as otherwise the results obtained would have been more consistent with the results given in this paper, and might have given information as to the slight difference due to that particular composition of alloy tested.

Importance of Lead Addition

If it is accepted that ½ per cent of lead raises the maximum stress at 500 degrees Fahr. from 9.75 tons to 16.5 tons, that proportion of lead becomes an essential ingredient in bronze, that is, subjected to temperatures above 350 degrees Fahr. It also becomes necessary to inquire whether any further advantage can be gained by adding a larger proportion of lead.

Figs. 3 and 4 show that this is not

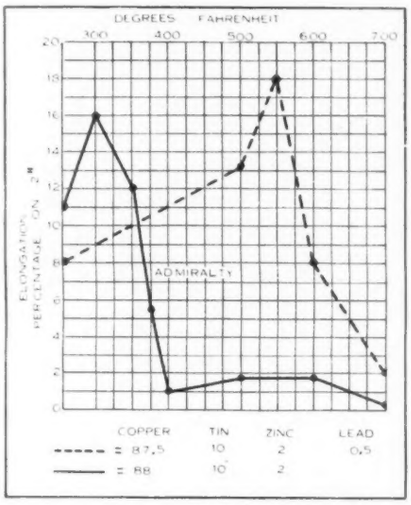


FIG. 2—CHART SHOWING ELONGATION OF ALLOYS

the case; but it is surprising that with so large a proportion as 16 per cent of lead the maximum stress at 500 degrees Fahr. is 12½ tons as against 9.5 tons without any lead. In making these experiments the lead was added at the expense of the copper. So the last result would be 72 per cent copper, 10 per cent tin, 2 per cent zinc, 16 per cent lead.

Experiment No. 1

In making the foregoing experiments the question arose as to whether any of the results were due to the absorption of oxygen from the atmosphere by the alloy when in a molten condition. It is difficult to determine the content of oxygen in bronze, and therefore the following experiments were conducted with best selected copper:

A new 100-pound plumbago crucible was taken; as soon as the copper was sufficiently hot an ingot was cast and the rest of the metal was returned to the fire for an hour, when a second ingot was cast and the same procedure repeated for the third ingot. There were thus three ingots cast from the same crucible at intervals of one hour. Analysis showed the oxygen contents of the three were as follows:

No.	Oxygen, per cent.	Cuprous oxide, per cent.
1	0.032	0.285
2	0.272	2.499
3	0.404	3.605

Experiment No. 2

Two new plumbago crucibles containing 100 pounds of Best Selected copper were taken, and ¼ pound of 10 per cent phosphor-copper was added to one, and 0.6 ounce aluminum to the other, as deoxidizers. The copper was covered with glass, so that when molten no air could come in contact with it; three ingots were cast at intervals of one hour, as in the former experiment, the glass being left on during the casting. The oxygen contents with both aluminum and phosphorus as deoxidizers were as follows:

ALUMINUM AS DEOXIDIZER.

	Oxygen, per cent.
1	0.084
2	0.080
3	0.092

PHOSPHORUS AS DEOXIDIZER.

	Oxygen, per cent.
1	0.036
2	0.036
3	0.036

Both sets of results show that if the metal is kept from contact with the air when molten no oxygen is picked up, and if this precaution is not taken each melting will result in an increase in the content of oxygen, and this conclusion was accepted and acted upon when making the following experiments. The products were not analyzed for oxygen on account of the previously mentioned difficulty of such analysis.

Experiment No. 3

One new plumbago crucible containing 100 pounds of 87½ per cent copper, 10 per cent tin, 2 per cent zinc and ½ per cent lead was covered with glass to exclude the air and melted; another exactly similar charge was allowed ample opportunity to pick up oxygen by being repeatedly skimmed and left standing in the air after being taken from the fire. Test pieces and a heavy flange casting with a light and thin nipple on each side, were cast from each crucible.

The flange castings were broken and examined very carefully, and both appeared as sound as it is possible to get a casting. The test pieces

gave the following results when tested cold and under heat:

	Temperature.	Maximum load in tons per square inch.	Extension on 2 inches per cent.
First charge covered with glass to exclude oxygen	Cold	15.17	9.0
	At 500° F.	13.73	10.5
Second charge uncovered to absorb oxygen	Cold	16.55	12.5
	At 500° F.	15.15	14.0

Experiment No. 4

To complete the foregoing results, experiment No. 4 was made, which consisted in casting a similar flange and test pieces in *twice run* metal The flange casting again proved sound and the test pieces gave the following results:

	Temperature.	Maximum load in tons per square inch.	Extension on 2 inches per cent.
Metal twice run without any precaution to prevent absorption of oxygen.	Cold	15.19	8
	At 500° F.	16.15	14

Conclusions

The foregoing experiments point to the conclusion that in an alloy of 87½ per cent copper, 10 per cent tin, 2 per cent zinc and ½ per cent lead, no benefit results from the deoxidation of the metal, or in taking special precautions to prevent the metal absorbing oxygen.

There is another feature of considerable interest in these alloys. When the alloy that is free from lead is turned in the lathe the turnings have a considerable curl, but the addition of ½ per cent of lead materially reduces the length of the turnings.

It would naturally be supposed that this feature is due to the fact that without the lead the alloy has an elongation of 11 per cent in 2 inches and with the addition of the lead the elongation is reduced to 8 per cent, and that the turnings break off more readily for this reason.

The same test pieces from which the turnings were made when cold were then heated and turned at 550 degrees Fahr. The alloy without the lead still presented the same curly appearance, and the turnings from the alloy containing the ½ per cent of lead were a little longer than the turnings produced at the cold.

The elongation of the alloy containing ½ per cent of lead at 550 degrees Fahr. is 18 per cent in 2 inches; whereas the elongation of the alloy without the lead falls at this temperature below 2 per cent.

As lead has such a marked effect on bronze, enabling it to be used without loss of strength up to 550 degrees Fahr., it seems reasonable to expect that some other metal might be added that would enable the bronze to withstand even higher temperatures.

Addition of Silver

With this object in view 87.25 copper was melted in a new crucible and 0.25 of silver was added when the copper was melted and the whole mass stirred. Ten per cent of tin, 2 per cent of zinc and ½ per cent of lead were then added and again stirred. Two test pieces were prepared and tested at 700 degrees Fahr. One test piece gave a maximum load of 8.11 tons, the other 8.75 tons.

The extension in neither case exceeded 0.5 per cent in 2 inches. The maximum load is practically the same as without the silver, and the extension not so good.

Nickel is not very promising, as in small proportions it seems invariably to liberate some occluded gas on cooling and produces porous castings.

Aluminum is objectionable, because in even small proportions it seems to add materially to the amount of the contraction of the casting on cooling.

Iron is strongly objected to in fine bronzes, as it combines with the tin and separates out into hard masses in the casting.

The subject seems to call for further research, as it is possible that small proportions of some of the rarer metals may have a beneficial effect.

With the present use of superheated steam it is very desirable that a bronze should, if possible, be produced that can be used with safety at 700 degrees Fahr.

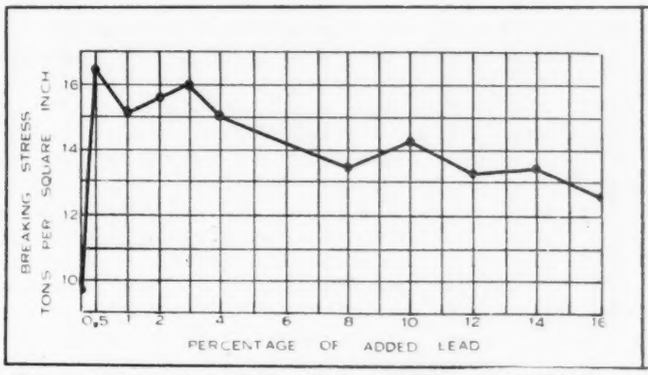


FIG. 3—BREAKING STRESS WITH VARYING PERCENTAGES OF LEAD; TESTED AT 500 DEGREES FAHR.

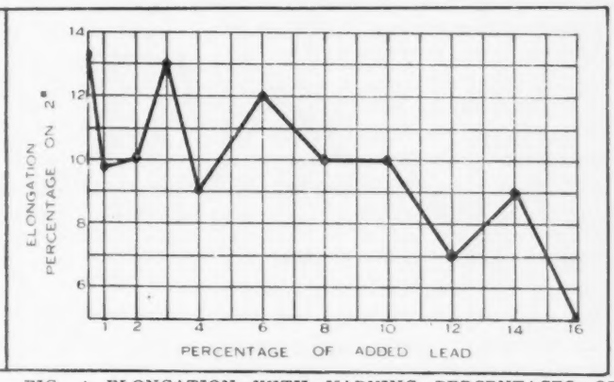


FIG. 4—ELONGATION WITH VARYING PERCENTAGES OF LEAD; TESTED AT 500 DEGREES FAHR.

Aluminum Die Castings

By A B Norton

THE term *die casting* is used to designate a type of castings which are made in permanent, metallic molds. As such, it embraces a wide variety of work which is assuming more and more importance. The development of the industry is proceeding so rapidly that producers and consumers in general lack definite information as to the alloys used, or the advantages, possibilities and limitations involved.

Four main classes of alloys are now in use. The bases of these alloys are (1) zinc, (2) tin, (3) lead, (4) aluminum.

Low Shrinkage Alloys

The zinc, tin and lead base alloys are low melting and of low shrinkage. The problems involved in making them therefore were attacked early and castings of this type have been on the market for

*Presented at the Chicago meeting of the American Institute of Metals.

some time. They consist mostly of small parts used in places where they are not required to possess much strength or rigidity and, as such, when properly made, they serve very well the purpose for which they are intended. The lack of strength, the low melting point, and heavy weight (with its consequent cost) of these alloys, have made aluminum die castings very desirable, but the difficulties involved in their manufacture have retarded the development of the industry to such an extent that at present there is only one plant in America in which the manufacture of large aluminum die castings is being carried on commercially.

The principal difficulties met with are (1) the high melting point of aluminum (as compared to tin, lead and zinc), (2) the tendency of molten aluminum to absorb iron, (3) the relatively high shrinkage on solidification, and (4) the weakness at the solidification point developed by aluminum when burned or soaked.

The first two features mentioned have hindered the direct adaptation of pressure machines of the iron plunger type, since certain parts of these tend to wear out rapidly, due partly to solution of the iron or steel in molten aluminum, and partly to oxidation about the heat source.

The high shrinkage on solidification and the weakness of burned or soaked aluminum during that period, have been fruitful sources of trouble in the form of cracked castings.

Cadmium Alloy

Some attempts to remedy the shrinkage have been made by using alloys developed for that purpose. An alloy of about 7 per cent cadmium with a small percentage of manganese, was evidently designed with this purpose in mind. The manganese, though beneficial in a different way, woulld tend to lessen the advantage gained from the cadmium. About 2 per cent of tin has likewise been added to an 8 per cent copper alloy. This tends to help by causing the aluminum to stretch rather than crack, but its effect is not so apparent in a well designed mold.

Zinc is a common and useful hardening element for aluminum castings made in sand, but its use in die castings is prevented by the hot shortness of zinc-aluminum alloys. It is not unknown in the field, but it is extremely difficult to handle.

The alloy used almost entirely by the Aluminum Castings Co. is practically No. 12. This particular composition is desirable from many viewpoints. It can be prepared easily without overheating any portion of the component metals. It is strong while solidifying, strong at high temperatures, and also at ordinary temperatures. The practice has been perfected with the use of it, and a change in the alloy would necessarily mean some revision of methods and manipulation.

The process of manufacture of aluminum die castings is difficult to describe, since each job is a problem of its own and must be worked out individually.

	Sand Castings.	Die Castings.
Tensile strength, pounds per square inch	20,000[1]	25,000[2]
Approximate elastic limit (Stress for 0.01 inch elongation in 2 inches)	13,000[1]	13,000[2]
Percent elongation in 2 inches	1.7[1]	3.1[2]
Specific gravity	2.84	2.87

[1]Average of hundreds of bars.
[2]Average of 48 test bars.

The molds are made of iron. They are constructed in sections containing a large number of loose pieces, the number varying, of course, with the size and complexity of the casting.

The loose pieces serve several purposes. They may be used as cores, as chills, or to form projecting parts which otherwise would interfere with the opening of the mold.

Making the Die Casting

The operation in brief, then, is to assemble the mold, heat it to the proper temperature, insert the cooling pieces and pour the casting. The loose pieces are then removed in the proper order at the proper times, and the die is taken apart for removal of the casting. In order to get more complete control of the operation, most of the molds now in use are mechanically operated.

It is evident from the preceding description that the aluminum die castings must be made in molds which are a perfect machine fit. The mechanics employed must be of the highest class. The mold itself will not work at all unless accurately constructed. The castings produced therefore, must, conform to this same high standard of perfection, as to dimensions.

The accuracy attainable in the making of an aluminum die casting results in a considerable reduction of the number, extent and expense of the machining operations required. It is possible to meet dimensions in most cases with a very slight variation. The necessary allowance for finish, in many cases is zero, and, as a consequence, the customer gets a casting of the minimum weight consistent with his requirements. Since the castings are all alike, they fit the jigs accurately and readily, thus saving time and increasing the accuracy of the necessary machining operations.

The metal used in die castings has to be handled with the greatest of care, and, in general, does not come in contact with sand. Consequently, sand inclusions and hard spots cannot be present to dull tools or knock them out of alignment.

The molds impart to the metal a smooth surface and an exceedingly close grain. This fine grain takes a brilliant polish readily and rapidly. It is also practically impervious to water and oil, due to the fineness of structure, combined with the freedom from dross and dirt.

Comparative figures of the physical properties of die castings and sand castings follow:

The above table shows that aluminum die castings are much stronger than the sand castings, and, in fact, pound for pound, they exceed cast iron and ordinary brasses and bronzes.

The high strength, resistance to heat, light weight and beautiful color of the aluminum permanent mold products have caused their adoption already in numerous classes of work. This includes many types of electrical, scientific and measuring instruments, cash registers, automatic vending machines, typewriters, adding machines, cooking utensils, automobile and aeroplane parts.

Aluminum Pistons

One of the newer adaptations is in the manufacture of pistons for automobile engines. Die cast aluminum pistons were used successfully in most, if not all, of the French racing cars in the recent 500 mile event at Indianapolis.

The process, like any other, has its limitations. Getting a job under way involves a considerable expenditure and hence prevents the acceptance of small orders. The design and preparation of the dies is an expensive process and usually the casting desired has to be altered somewhat to adapt it to this form of manufacture.

The process in America at present is limited largely to pieces in which the coring can be designed so as to permit the use of metallic cores. In France large oil pans have been made in which sections almost entirely enclosed were obtained through the use of sand cores. Some pieces are being made here with sand cores, but it is far preferable, where possible, to redesign a job so as to obtain all of the advantages afforded by all metallic molds.

The production of commercial castings, as outlined, is not a mere matter of getting a certain mysterious machine adaptable to all purposes and setting it to work. On the contrary, each individual job requires a separate solution. Here the first big factor is the experience of the engineer who designs the mold. He requires also the co-operation of the engineer who designed the casting, in order that changes required will be made whenever possible. After the mold is made, the best conditions for operation must be

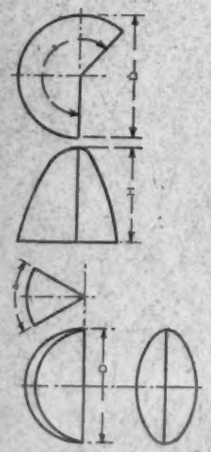
(Continued on page 463.)

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR FINDING THE WEIGHTS OF CASTINGS

By W. L. Tryon



To find the weight of a sector of a paraboloid, multiply the diameter of the base squared by the height by the number of degrees in the angle by the value of k (see table below) corresponding to the weight per cubic inch of material used.

$$W=D^2Hak$$

To find the weight of a spherical wedge, multiply the diameter of the sphere cubed by the number of degrees in the angle by the value of m.

$$W=D^3am$$

ALL DIMENSIONS IN INCHES AND WEIGHTS IN POUNDS

Wt. per cu. in.	k	m	Wt. per cu. in.	k	m	Wt. per cu. in.	k	m	Wt. per cu. in.	k	m
.096	.000105	.000140	.210	.000229	.000305	.330	.000360	.000480	.450	.000491	.000654
.100	.000109	.000145	.220	.000240	.000319	.340	.000371	.000495	.460	.000501	.000669
.110	.000120	.000160	.230	.000251	.000334	.350	.000382	.000509	.470	.000512	.000684
.120	.000131	.000174	.240	.000262	.000349	.360	.000393	.000524	.480	.000523	.000698
.130	.000142	.000189	.250	.000273	.000363	.370	.000403	.000538	.490	.000534	.000712
.140	.000153	.000203	.260	.000283	.000378	.380	.000414	.000553	.500	.000545	.000727
.150	.000164	.000218	.270	.000294	.000393	.390	.000425	.000567	.510	.000556	.000741
.160	.000174	.000233	.280	.000305	.000407	.400	.000436	.000582	.520	.000567	.000756
.170	.000185	.000247	.290	.000316	.000421	.410	.000447	.000596	.530	.000578	.000770
.180	.000196	.000261	.300	.000327	.000436	.420	.000458	.000611	.540	.000589	.000785
.190	.000207	.000276	.310	.000338	.000450	.430	.000469	.000625	.550	.000600	.000800
.200	.000218	.000291	.320	.000349	.000465	.440	.000480	.000640	.560	.000611	.000815

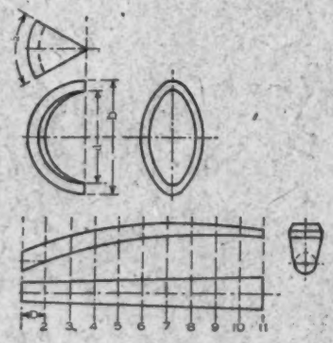
INTERPOLATION TABLE

Add'l. Wt.	Add'l. k	Add'l. m	Add'l. Wt.	Add'l. k	Add'l. m	Add'l. Wt.	Add'l. k	Add'l. m
.001	.000001	.000001	.004	.000004	.000006	.007	.000008	.000010
.002	.000002	.000003	.005	.000005	.000007	.008	.000009	.000012
.003	.000003	.000004	.006	.000007	.000009	.009	.000010	.000013

For method of Interpolation see Data Sheet No. 129.

FORMULAS FOR FINDING THE WEIGHTS OF CASTINGS

By W. L. Tryon



To find the weight of a hollow spherical wedge, multiply the difference between the outside diameter cubed and the inside diameter cubed by the number of degrees in the angle by the value of m (see table on preceding Data Sheet) corresponding to the weight per cubic inch of material used.

$$W=(D^3-d^3)am$$

To find the weight of an irregular casting, which cannot be divided into elementary solids, use the following method based on Simpson's rule:

Divide the length of the casting into an even number of parts of equal length D (the greater the number of divisions, the greater will be the accuracy in the final result) by parallel planes. Add the areas of the two ends and designate the sum A. Add the areas of the cross-sections made by the even cutting planes, i. e. 2, 4, 6, etc., and designate this sum by B. Then add the area made by the odd cutting planes, except the ends, calling this sum C.

The weight of the casting is equal to the sum of A, *four* times B and *two* times C multiplied by D, by the value of K.

$$W=(A+4B+2C)DK$$

ALL DIMENSIONS IN INCHES AND WEIGHTS IN POUNDS

Wt. per cu. in.	K	Wt. per cu. in.	K	Wt. per cu. in.	K	Wt. per cu. in.	K	Wt. per cu. in.	K	Wt. per cu. in.	K
.096	.0320	.170	.0567	.250	.0833	.330	.1100	.410	.1367	.490	.1633
.100	.0333	.180	.0600	.260	.0867	.340	.1133	.420	.1400	.500	.1667
.110	.0367	.190	.0633	.270	.0900	.350	.1167	.430	.1433	.510	.1700
.120	.0400	.200	.0667	.280	.0933	.360	.1200	.440	.1467	.520	.1733
.130	.0433	.210	.0700	.290	.0967	.370	.1233	.450	.1500	.530	.1767
.140	.0467	.220	.0733	.300	.1000	.380	.1267	.460	.1533	.540	.1800
.150	.0500	.230	.0767	.310	.1033	.390	.1300	.470	.1567	.550	.1833
.160	.0533	.240	.0800	.320	.1067	.400	.1333	.480	.1600	.560	.1867

INTERPOLATION TABLE

Add'l Wt.	Add'l. K	Add'l. Wt.	Add'l. K	Add'l. Wt.	Add'l. K
.001	.0003	.004	.0013	.007	.0023
.002	.0007	.005	.0017	.008	.0027
.003	.0010	.006	.0020	.009	.0030

For method of Interpolation see Data Sheet No. 129.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Strong Bronze Mixtures

We have been experiencing considerable difficulty in obtaining a phosphor bronze mixture suitable for making springs, which are coiled flat. The stock should be ¾ inch wide and 0.03 inch thick. The material we have been using lacks uniformity and loses its resiliency after short usage. What non-ferrous metal can you recommend for this service and also furnish an alloy suitable for this use? We would like to have typical manganese and phosphor bronze mixtures with advice regarding the special precautions necessary in their manufacture. Will a manganese bronze mixture have the same hardness and wearing qualities as a mixture containing 80 per cent copper and 20 per cent tin?

As compared with steel, brass or bronze is a poor material for springs. Occasionally, conditions arise where a non-ferrous metal has to be used and then the only choice to be made is between a brass or bronze alloy. Brass possesses greater resilience than phosphor bronze, but is liable to crystallization, although alloys containing iron are said to be less effected this way.

An excellent phosphor bronze mixture for springs follows: Copper, 94¾ pounds; tin, 5 pounds and 15 per cent phosphor bronze, ¼ pound.

A brass spring mixture can be made as follows: Copper, 70 pounds, which is melted under a cover of charcoal and then thrown lightly on top of the molten metal; 1 pound of yellow prussiate of potash wrapped in paper; close the furnace for five minutes and then observe whether the water of crystallization has been driven off from the potash. If so, stir the potash into the copper, exercising care in performing this operation, and add 2 ounces of manganese-copper. After again stirring the metal, add 29 pounds, 10 ounces of zinc and lastly, 6 ounces of tin.

The following is a typical high tension phosphor bronze mixture: Copper, 90 per cent; tin, 5 per cent and phosphor tin, 5 per cent. When phosphor bronze is used for bearings, lead is added, which weakens the metal, but imparts antifrictional properties. To the foregoing phosphor bronze add 10 pounds of lead and decrease the copper by the same amount.

An excellent manganese bronze is made as follows: Copper 56 pounds; pure zinc, 42 pounds; iron, 1.5 pounds; tin, 1 pound; ferro-manganese, ½ pound and aluminum ½ pound. Melt the copper, add the ferro-manganese in powder form and stir thoroughly. Then add the iron gradually in the form of thin strips of planished sheets, stir again, cover with charcoal and superheat for 10 minutes. Then add the aluminum, next the zinc and lastly the tin. Stir well and cast into ingot form. The ingots then are remelted for casting purposes.

Manganese bronze will not possess the same hardness as a mixture of copper, 80 per cent and tin 20 per cent, nor can it be used as a bearing metal with any degree of success.

Elimination of Dissolved Silica

Can you furnish us any information regarding the elimination of dissolved silica from molten metal, such as copper or nickel? If lime will slag off the silica, what method should be pursued in using this flux?

Silica cannot be dissolved by molten metal as it is an oxide and while some metals, notably copper, possess the power to dissolve their own oxides, they will not dissolve, to any appreciable extent, foreign oxides which may be stirred into them. Silica, SiO_2, is merely sand and sand and metal, as is well known, will not mix. However, when the oxygen is removed from silica, the silicon is left and this will unite with copper and other metals in almost any proportion. When silicon is present in any copper alloy, the effect on the molten metal is so similar to that produced by aluminum that it is difficult to distinguish between them. Sometimes when copper has been treated with silicon a small amount of oxide in the form of a white, fine powder will be held in suspension in the metal and will produce defects in the castings. In this case the silicon is converted into oxide while dissolved in the metal and as the oxide does not possess sufficient buoyancy to rise to the surface, it remains in the metal which has been rendered viscous or oily by the dissolved silicon. This condition, however, does not prevail to any extent and will require little consideration.

When the metal contains both lead and silicon, it is impossible to produce clean castings, as a large amount of white, powdery dross is formed and this lodges in the castings. This, however, is not silica, but lead silicate and is due entirely to the lead in combination with the silicon. In the refining furnace sand is added to remove lead from the alloy and lead, of course, will remove silicon, but this cannot be accomplished in crucibles.

Lime will not remove silicon nor will any other substance used ordinarily as a brass foundry flux. Silicon has to be oxidized from the metal in which it may be mixed and the only way to accomplish this in crucibles is by the addition of copper oxide. The contaminated metal should be melted and raised to a high temperature, the oxide added and stirred in. A reaction will occur between the oxygen and the silicon and the latter is removed in the form of an oxide. To produce a fluid slag that will not carry away too much copper, the addition of powdered fluorspar is essential. The addition of copper oxide should be repeated until the molten copper bubbles and appears blue underneath the slag. The metal should be allowed to cool to a normal temperature and if it still continues to bubble, phosphor-copper should be added until the bubbling ceases. The metal then is ingoted.

Alloy for Machine Screws

One of our customers uses a large number of small, yellow brass machine screws, which corrode rapidly, and he would like to know whether he can obtain these screws in German silver, copper, manganese-bronze or Monel metal. Also, we are making castings for a firm which uses them on gas lights and the castings are subject to a temperature of from 1000 to 1200 degrees Fahr. These castings corrode rapidly, a black crust forming on them, and consequently they become useless. Is there a metal mixture that can be used to overcome this difficulty?

It is doubtful if German silver would be satisfactory for the purpose stated. The temperature is too high for the use of copper, manganese-bronze or tin bronzes. Monel metal might meet the requirements, and can be purchased in rods suitable for making the machine screws. A 10 per cent aluminum bronze would withstand the high temperature

better than any other alloy and the cast parts might be made of this mixture.

The following alloy generally is presumed to be non-corrosive: Copper, 80 per cent; phosphor-copper, 0.5 per cent; nickel, 15 per cent; zinc, 8 per cent; aluminum, 3.50 per cent and tin, 3 per cent.

The best alloy, however, that can be used for the purpose mentioned, follows: Copper, 67 per cent; nickel, 30 per cent and aluminum, 3 per cent.

How to Use Scrap Copper Wire

Will you kindly advise us how to make sound castings from scrap brass and copper wire?

Use about 50 per cent scrap brass and 50 per cent new alloy, the basis of which may be copper wire. Melt the brass first, or if there is room in the crucible after the brass is charged, some of the copper may be placed on top of the brass. When this charge begins to melt, throw in sufficient charcoal to cover the metal to a depth of 1 inch, allow the charge to melt and then add the balance of the copper as rapidly as the melted metal will take it without chilling. The copper should be submerged in the molten metal and should be stirred thoroughly. After all of the copper is charged, add a little more charcoal, close the furnace and allow the metal to become hot. When the charcoal is pushed aside, the surface of the molten metal should be free from pasty metal. The mixture is then added, the metal is well stirred, the pot is pulled and the metal is poured.

Forced or Natural Draft

I have a battery of five brass furnaces, three of which take 150-pound crucibles, although the other two will take 300-pound crucibles. I melt with coal, using forced draft derived from a small fan discharging into closed ash pits underneath the furnaces. The chimney is small and low and is of no use so far as draft is concerned. I melt mostly bronze, copper and tin and have considerable trouble with porous castings. Would a natural draft furnace give better results, and if so, what would be the proper size and height of the stack?

No particular advantage would be derived in changing the furnaces from forced to natural draft, as this would involve considerable expense, and just as good castings can be made with the one type of furnace as the other. The natural draft furnace, however, would melt more slowly than the one driven by blast unless attached to a very high chimney. The shop would be more habitable, however, with natural draft furnaces in place of the present installation, because the products of combustion would be drawn away by the stack instead of being forced into the atmosphere of the workroom, which at present undoubtedly is the case. This naturally would result in better work by the molders and probably more careful melting on the part of the furnace tenders with consequent lower average loss. A forced draft furnace requires a larger flue than one of the natural draft type, and the latter should be equipped with a flue at least 8 x 6 inches in order to draw well. The size of the main flue should be equal to the area of all the furnace flues entering it, with a margin of 10 to 25 per cent above this if the furnaces are to be run steadily every day. Aside from insuring more comfortable and healthful working conditions, the natural draft furnace is just as liable to produce porous castings as the one now being used, this difficulty being due either to careless melting or the use of alloys containing insufficient deoxidizers. Careful melting entails the use of a covering of charcoal or broken glass on the molten metal and repeated attention during the period of melting. Alloys of copper and tin require the addition of zinc, phosphorus, lead, manganese, etc., to promote soundness, and if the mixtures do not contain any of these elements, use either zinc or phosphorus, the former in proportion of at least 2 per cent and the latter in the form of 15 per cent phosphor copper in the proportion of ¼ to 1 per cent. Red brass mixtures containing high percentages of zinc and lead and a small amount of tin are melted to better advantage without deoxidizers, as the latter may cause segregation and promote heterogenous fracture and the consequent weakness of the alloy.

Brass Casting Mixtures

Kindly furnish us with a number of mixtures for light and heavy brass and one for bronze bearings.

An excellent mixture for light brass work follows: Copper, 88 pounds; tin 6 pounds; zinc, 3½ pounds and lead, 2½ pounds.

For heavy brass castings the following may be used: Copper 87 pounds; tin, 10 pounds and zinc, 3 pounds.

A mixture for high tensile phosphor bronze follows: Copper, 90 pounds; tin, 5 pounds and phosphor tin, 5 pounds.

For a bearing metal the following is recommended: Copper, 78 pounds; tin, 7 pounds and lead, 15 pounds.

A stronger bearing metal than the foregoing can be made of 80 pounds of copper, 10 pounds of tin and 10 pounds of lead.

Difficulties Due to Oxidation

We are making bronze rings, 10 inches in diameter and approximately 12 inches long. The metal is porous and has the color of manganese. The mixture consists of one-third new metal and two-thirds miscellaneous scrap. The new metal includes 9 pounds of copper to 1 pound of tin. The color undoubtedly is imparted by the use of manganese bronze in the scrap.

Oxidation is the cause of the difficulty in this instance and it is only natural to suspect the miscellaneous scrap which forms two-thirds of the mixture. The sample of metal forwarded contains oxide or metal ashes, the presence of which is responsible for the pitted appearance of the casting after it is machined. The remedy is to abandon the use of scrap, as such metal is utterly worthless unless refined. It would be more economical to use the 9 to 1 mixture entirely, but this alloy also will produce porous castings unless some deoxidizing agent, such as phosphor-copper is used, which should be added in the proportion of 2 per cent. The following alloy probably will serve your purpose to advantage: Copper, 87 pounds; tin 7½ pounds; zinc, 3½ pounds and lead, 2 pounds.

White Spots on Brass Castings

We make a specialty of brass busts, tablets and statues and we are using a mixture consisting of copper, 90 per cent; zinc, 7 per cent and tin 3 per cent. Frequently white spots occur on the castings, which seem to be caused by zinc, as they are not due to the tin because they turn black. The best of metal is employed and we are wondering what causes these spots. Do you think that this difficulty can be traced to the metal and if so, how can it be overcome?

We fail to see how this difficulty can be attributed to the metal. The formula constitutes a good, cheap grade of brass and neither the tin nor the zinc is sufficiently high to cause liquation. There must be some other cause for the white spots, but from the information given, we are unable to state what it is.

The Wernicke-Hatcher Pump Co., Grand Rapids, Mich., has issued a four-page bulletin describing its rotary air compressor, which is designed for pressures up to 100 pounds per square inch. The bulletin includes a number of sectional views of the compressor, showing the mechanism in detail, and an explanation of the function of the various parts also is given.

Arrangement of Tanks in a Well-Equipped Plating Room

Results Accomplished by Scientific Management-I

By Seymour W Rowsbar

WITHIN the last decade there has been a remarkable development of practical ideas relative to electroplating, both in Europe and in the United States. A review of the most important of these improvements will show that the greater number deal directly with increased production rather than better quality of plating. In but few instances, however, do the measures influence the quality of the deposit materially. If judiciously employed, therefore, they mean economy and increased efficiency in the plating room. The strides made in the mechanical and electrical equipment of plants are perhaps most conspicuous, but the advancement made in the chemical efficiency of the processes is possibly of greater value to the plater as well as a source of satisfaction to the employer. Only a few years ago brass solutions were regarded as the most provoking and expensive time consumers a plater had to deal with. Today there are very few progressive platers who have not solved the brass plating problem to the extent of obtaining more constant and uniform results. Some of the latest improvements in nickel solutions have and will save thousands of dollars for the manufacturer. But in considering plating room efficiency and economy there are necessarily many other things to deal with.

That the plater is liable to fall into a self-satisfied state of existence because of past accomplishments is a fact too true. We may see living examples on every hand in shops equipped in the most primitive, inefficient and unsystematic manner. The results must be costly, but the foreman has grown up with the company perhaps and is determined to continue in the same well-worn groove and the management is short-sighted enough to allow him to do so. Most platers who are imbued with a love for their work have ambitions toward improvements in the methods they have adopted, but comparatively few firms appear to realize that unless research and experimental work is encouraged the future will find them far behind the leader, and the loss entailed by the delay will be irreparable.

Profitable Administration

No firm should expect to hold a foreman plater responsible for the successful management of a plating department unless the general factory organization is operated in such a manner as to allow him a fair chance to administer the affairs of the department profitably. The proper installation of suitable equipment solves about one-half of the problem of plating room efficiency, while the greater part of the remaining one-half rests with the foreman if the management is correct to this point. The foreman is not at fault when small quantities of work are required to be treated with an equipment designed for several times the quantity. The excessive cost of operation is perhaps one of the worries he meets daily, but is helpless to avoid. The foreman should not be required to chase work through other departments in order to keep his men and baths busy. If a foreman plater is necessary in the plant there is sufficient work in his department which requires his personal attention to justify absolute freedom from routine, clerical duties. The gathering of data, estimating costs, figuring values, selling prices, etc., naturally are expected of him and he should not be handicapped in this direction by petty duties which a less valuable man could perform.

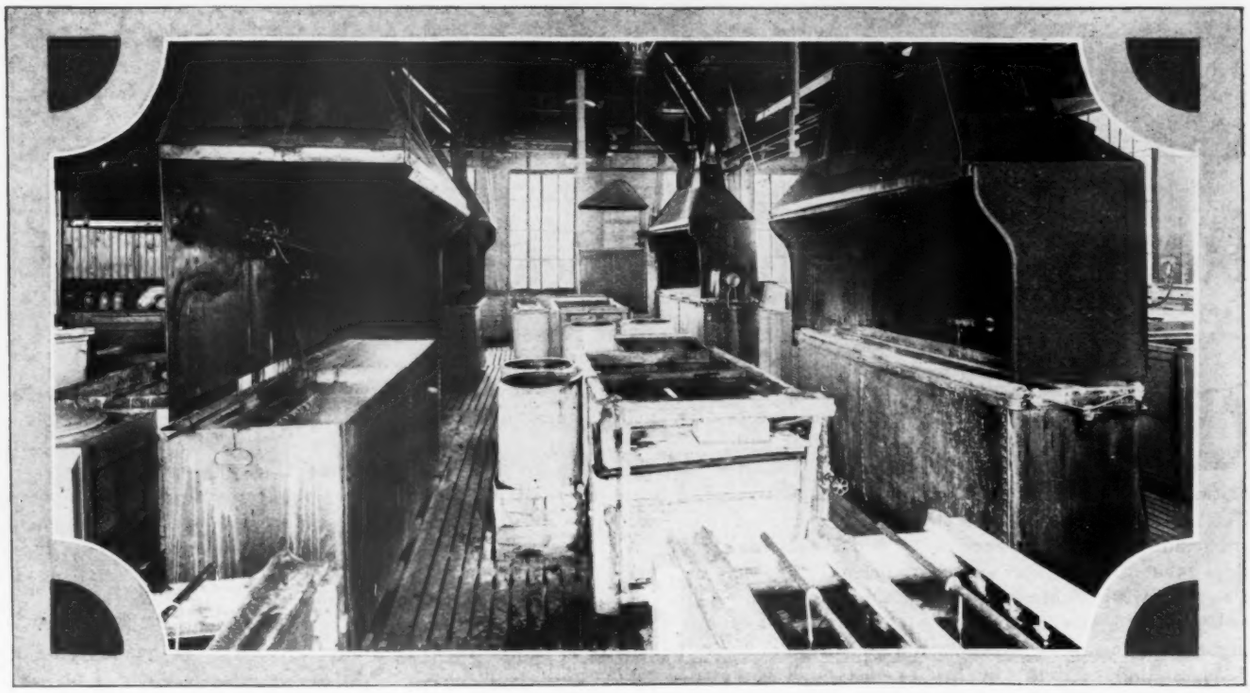
While not always requiring a sacrifice of time by the foreman, we believe that the reduction of prices on piece work or wage cutting, etc., should be done by the superintendent rather than the foreman, as thus the possibility of inefficient efforts on the

part of the men affected would be minimized. Some superintendents are a positive hindrance to economy and efficiency in plating plants under their supervision. We have in mind a case where steam coils were not allowed to be placed in a 500-gallon tank containing strong caustic solution, the tank being ordered equipped with an overflow pipe and live steam inlet for heating. The result has been very costly and decidedly inefficient in operation. Another insists upon having all sheet steel stampings washed in coal oil previous to delivery to plating department and then he persists in telling the foreman plater that he should be able to clean the steel effectively in a cold solution of soda ash. "Ye gods and little fishes," what should be done with him? It is indeed unfortunate that such men cannot see wherein they are incompetent and appreciate the efforts of a capable plater, cease dictating or assume a less officious demeanor toward those whom he has in charge and meanwhile take a lesson in electroplating common sense. The average factory superintendent knows little or nothing of the chemical reactions in or the significance of accurate and reliable electrical control for the baths in a plating room. He may be perfectly at home while dealing with lathes, shapers, molding machines or a gas engine, but in the plating room he finds a proposition entirely foreign to his training and in many cases rather than openly admit this deficiency, he will either interfere when not needed, or shun the department as much as possible, thus leaving the control of the department almost entirely in the hands of the foreman. In order to bear this responsibility creditably this man must be mentally and physically equipped for the purpose.

Working Foreman an Asset

In plating rooms connected with very large plants or in departments handling a great variety of finishes on high grade products, a scholarly foreman versed in the theory and practical in the application of modern ideas is undoubtedly a valuable asset to the firm, but in the average shop a conscientious working foreman who thoroughly understands the requirements of the firm from both the selling and manufacturing standpoint is more satisfactory and less expensive. "A man's initiative is not always due to superior intellect, but to the result of greater opportunities." Therefore, a plater should not be hampered in this direction too greatly. Frankly, the inefficiency of methods employed in a large number of plating shops is surprising in view of the fact that the system used successfully in the more progressive plants are not guarded as secrets. Conditions vary in different places, we admit, and a system which would be a success with one firm might require modifying to suit the conditions of another, but the task of adopting a system which will work in harmony with the general shop conditions should be undertaken thoughtfully and gradually by the foreman plater assisted by the superintendent. One serious evidence of inefficiency in modern plating room management is the stress and emphasis laid upon the securing of a mere elementary knowledge of the principles of electricity and chemistry by the foreman instead of an efficient attitude of mind, zest for conquering difficulties and the acquisition of power for accurate observation and logical deductions in everyday plating and finishing problems. These are the really important things which should form the foundation of an efficient education for the foreman plater.

A foreman must treat men as responsible beings and invite their confidence, encourage them to improve by home study or a course in chemistry at night school. When a workman makes an error, or is indirectly responsible for inferior results, a detailed explanation of the cause and effect and a properly dispensed admonition for the future will invariably create an incentive to make an effort toward improvement and greater care. The elimination of unnecessary motion can accomplish much in a plating room, in scouring, filling baths, scratch-brushing, removing parts from wires or holders, in fact at nearly every step in the treatment time and energy may be saved by motion study. If the foreman will observe the motions of each man while at work and correct the awkward or useless by instructing the men how to accomplish



AN EFFICIENT ARRANGEMENT OF COPPER PLATING TANKS, POTASH TANKS AND SWILLING TANKS WITH DIPS

the task easier, quicker and often better, the gain in time alone will be surprising. The workmen also will realize then that the duties are such as to demand experience and eventually appreciate the importance of the correction as he becomes more proficient.

The men should not be required to seek the foreman for instructions before commencing each new job. The foreman must keep his men supplied with work so that no waiting for instructions is necessary. The work also should be apportioned so that the responsibility for the performance of each function may be definitely fixed and every encouragement should be given the men to think out improvements. On lines other than jewelry and novelty goods the tank operator should be possessed of sufficient physical endurance to enable a continuous performance of duties without evidence of fatigue. Many of the operations must be quickly and uniformly carried out and a slow or half-exhausted workman is a very unpleasant spectacle when an extra rush is essential in order to get a special batch out or in fact at any time.

Men should be selected who are capable of receiving instructions as covering usual conditions for all time, thus avoiding the repetition of orders and constant attention from the foreman. To obtain the greatest efficiency from the men, transient help must be eliminated as much as possible. Organized systems to secure efficiency from this class has not and cannot prove effective. Good wages and hard work will not cause them to become interested beyond the hour of closing and pay day. They are sensible to their position and think and work accordingly. In fact, the efficiency of any system depends largely upon the labor personnel, whether composed of recruits, transients, experienced men or permanent employes of moderate ability. Our experience favors the latter for the average shop. The employment of very young boys in plating rooms is possibly not as common as in the past. This, we believe, is a step in the right direction. Small boys are cheap, but this advantage is offset by several disadvantages which are well worth considering. Boys are less careful and less reliable than men. They require more constant overseeing and must be kept within very restrictive bounds, or else the mischief-making propensities of youth will lead them to shirking of duties and interference with other employes, thus causing serious loss of time and output. The old saying, "One boy is a boy, but two boys equal but one-half a boy," works to perfection in a plating room. Nevertheless, the small boy has frequently been the source of great ideas and a suggestion from him is as valuable as one from the manager if it brings results.

In choosing the plating room staff it is unwise to be influenced too greatly by talk. Some of the best talkers and apparently the most industrious workers may be agitators of trouble, or confirmed loafers and the least efficient men in the department. Then there is the semi-automatic type of laborer. A plating room is no place for him. The foreman's assistant should be possessed of a preliminary education of such a degree that he can readily acquire accuracy in interpreting instructions and an unwillingness to jump at conclusions. He should have a receptive, active mind, be resourceful and possess the innate ability to visualize a described idea. A young man with no experience in plating can be trained to become very valuable to any plant in a reasonable time, and with his limited knowledge feels his dependence on his employer and usually is a more faithful and attentive workman because he receives better wages than the ordinary laborer and in many places could obtain employment only as a less valuable man in another shop. Recently, while questioning several applicants for a position as assistant plater, we were reminded of the farmer's explanation of the high cost of living. "Yes," he remarked, "when a farmer is supposed to know the botanical name of what he is raisin' and the zoological name of the insect that eats it and the chemical name of what will kill it, somebody's got to pay." Many young men who have mastered some of the technical terms used by the craft are under the impression that this knowl-

ANOTHER PART OF A WELL-EQUIPPED PLATING DEPARTMENT, SHOWING ELECTRIC CLEANER WITH CHANGE-OVER SWITCH ON THE POST, DRILL PRESS FOR MAKING HOLDERS, TUMBLERS ALONG THE WALL AND A MECHANICAL PLATING APPARATUS IN THE BACKGROUND

edge should command a good wage for them regardless of their proficiency as assistant platers.

Electro-plating processes fail to fascinate some managers or superintendents and as a result they often turn a deaf ear to suggestions made by the foreman plater. In a short time this treatment has its effect and the foreman will not mention the ideas he may gather, but at the same time fully realizes the value of a practical application of some of them to the work he has in charge. Thus efficiency is often defeated, as knowledge without action is about as valuable as the hole in a doughnut. If the foreman is sincere he should at least be given a hearing and a kind word of appreciation for his interest.

PLATING ROOM OF THE CANADA CYCLE & MOTOR CAR CO., TORONTO, ONT., SHOWING THE ROOM FROM THE PREPARATORY CORNER

The most important part of the plating room equipment being the dynamo entitles it to first consideration when referring to efficient plating methods. A mistake frequently made is the installation of a machine of insufficient capacity to allow of increase in size of plant, or the use of dense solutions requiring greater volume of current than the solutions heretofore in general use. We have found it advisable to allow from one-third to one-half the actual required capacity as surplus when selecting a dynamo for plating. The extra expense is slight compared to the cost of later replacing the machine with a larger one. In many plants the dynamo is badly abused or neglected and the condition of the machine often denotes the capacity of the foreman. A good dynamo kept in efficient condition is the foreman's most competent assistant, for if not reliable under the most trying conditions, his attention is required at critical moments when the plant is busy and he is needed elsewhere to supervise particular operations. If the machine is of suitable capacity, located in a dry place, free from vibration and kept clean, the only parts requiring special attention are the commutator and brushes. The oil chambers must be kept clean to avoid clogging, as then the oil escapes and reaches portions of the machine which are not easily accessible to clean and the oil retains dust and dirt until very soon these masses of matter cause trouble. The motor generator or the rotary converter are both efficient machines, especially where space is limited. The electric drive is the most efficient and economical for all purposes in the plating and polishing rooms. A motor is capable of automatically furnishing great reserve power immediately when required for many emergencies. No other source of power is so infallible and constant. It occupies little space, is easily operated and kept in working condition. The rotary converter is a motor and dynamo combined instead of being connected by a shaft as in the motor generator. The efficiency of these machines is slightly higher than in the double system, owing to less mechanical loss and less space occupied, the initial cost being about the same for machines of equal rating. Dynamos belted to line shaft are subject to a wide range of inequalities, which are entirely beyond the power of the foreman to correct and an interrupted service is a serious thing in a systematic plating department. Second only to the dynamo and power is the size and arrangement of the external circuit consisting of busbars and tank leads. These must be large enough to conduct all the current available or required at the various points in the circuit for a continuous run throughout a working day without heating. They must be insulated from any possible source of grounding or short-circuiting by careless employes, or the crystallization of metallic salts in obscure places. The flat bar is preferable for many obvious reasons and very few platers are now installing the round conductors. Increased efficiency does not necessarily imply that the old equipment must be discarded and a new one installed, but by studying the needs of the particular plant a shifting of certain portions to less important points and utilizing the very best equipment in a more efficient manner will result in a remarkable change throughout the entire department. The rheostats may be an old style and ineffective because of improper resistance coils or wires. If the base is in good condition and the castings large enough to drill for larger coils or wires, the old instruments may be cleaned, refinished and new coils inserted at a nominal cost.

(*To be continued.*)

Personal

J. R. Metcalf has been elected treasurer of the Erie Malleable Iron Co., Erie, Pa.

Henry Lindenberger, president of the U. S. Reduction Co., Chicago, recently returned from a business trip to Europe.

Robert E. Wilber has been appointed assistant to the general manager of the Bethlehem Foundry & Machine Co., South Bethlehem, Pa.

J. P. Pero Jr., formerly vice president and general manager of the Franklin Park Foundry Co., Franklin Park, Ill., has been elected president to succeed the late James P. Walsh.

D. T. Williams has retired as president of the D. T. Williams Valve Co., Cincinnati, and has been succeeded by Robert E. Mullane, treasurer. Francis X. Pund was elected vice president.

James F. Conran, formerly manager of the New York City branch of the Standard Sanitary Mfg. Co., Pittsburgh, has been appointed general sales manager of the company.

Dudley Willcox, employed by the Tabor Mfg. Co., Philadelphia, during the past six years, has resigned his position to take up a course in electrical engineering at Princeton University.

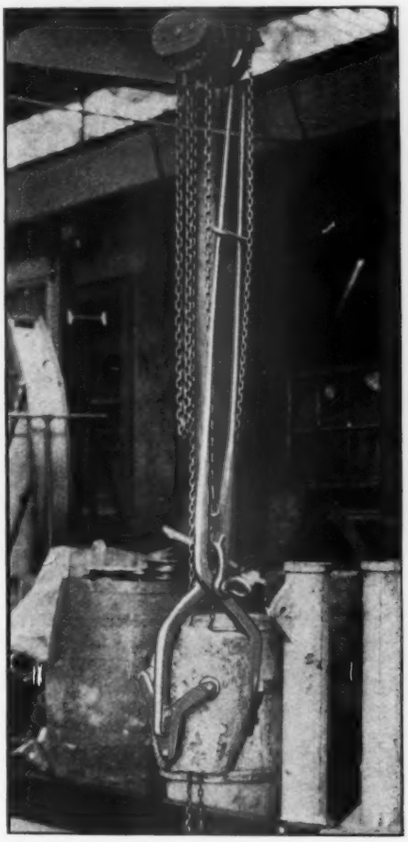
J. T. Stoney, superintendent for the past seven years of the foundry operated by the Ferro Machine & Foundry Co., Cleveland, has been appointed factory manager of the J. H. McLain Co., Canton, manufacturer of hot water and steam heaters, radiators and supplies. R. E. Stoney has been appointed foreman of the heater foundry operated by the McLain company.

W. E. Raymond, well known in the stove industry of Canada and the United States, has been made general manager of the Copp Stove Co., Ltd., Fort William, Ont., to succeed Fred W. King. This company will add a foundry jobbing business and other lines to its present output of stoves, heaters and furnaces. The western traveling staff, under J. A. Evans, will be increased.

W. C. Schade, recently appointed general manager of the Phoenix Iron Works Co., Meadville, Pa., has taken up his new duties. He resigned from the presidency of the Cherry Tree Iron Works, Cherry Tree, Pa., in February of this year, but owing to the inability of the company to find a successor, his resignation was not accepted.

A. H. Whiteside has been appointed vice president and general sales manager of the Goulds Mfg. Co., Seneca Falls, N. Y., to succeed W. E. Davis, who has been obliged to give up some of his active duties because of injuries received several months ago. Mr. Whiteside has held various positions in the machinery and allied trades for the past 15 years, having been connected with the Sterling Boiler Co., as southern manager, the Westinghouse Electric & Mfg. Co., as its Baltimore representative and the Allis-Chalmers Co., as manager of its power and electric department, in charge of all its pumping engine and centrifugal pump business.

J. C. Gorton has entered the employ of the Ferro Machine & Foundry Co., Cleveland, as factory engineer. Mr. Gorton has formerly been connected with



CRUCIBLE TONGS

the Brown & Sharpe Mfg. Co., Yale & Towne Mfg. Co., E. D. Leavitt, and with the American Locomotive Co., as assistant engineer. F. J. Patterson and H. H. White have joined the sales force of the Ferro Machine & Foundry Co., and C. W. Mason will take charge of the marine engine promotion department. Ernest R. Fried has been employed as mechanical engineer, in charge of the motor engineering department.

F. Thornley, of W. Thornley & Sons, Ltd., Sydney, Australia, attended the exhibit of foundry and machine shop equipment at Chicago, while passing through that city on his return to Australia. The Thornley company manufactures railroad supplies, signaling apparatus, structural work and special machinery and is desirous of extending its business connections in the United States.

A. Lincoln Reiley has been elected secretary of the Warren Foundry & Machine Co., Phillipsburg, N. J., to succeed S. A. Bristol. Mr. Reiley has been in the employ of the Warren company for some time and his new position is a promotion.

Crucible Tongs

The accompanying illustration shows a crucible tongs of new design recently placed on the market by the New Jersey Foundry & Machine Co., 90 West street, New York. The tongs are provided with triangular fingers so that there are always at least six bearing points on each side of the crucible. This tends to prevent the crucibles from slipping out of the tongs and also is said to reduce the danger of breakage. The triangular frames or fingers have sufficient play to insure a full bearing for all three of the contact plates. Each contact plate has a concave inner surface.

The tongs do not need to be hammered or re-inforced in fitting them to crucibles of various sizes. Ordinarily one set of tongs will fit three sizes of crucibles. It is said that the distribution of the pressure over several points on the crucible lengthens its useful life considerably.

Aluminum Die Castings

(*Continued from page* 456.)

determined and the operators must be trained to handle them. This experimenting is necessarily extremely expensive, and would be prohibitive but for the high production obtained from a mold, once it is in working order.

The process contains features which may be profitably adapted to brass die casting work, but our experiments in this particular are incomplete as yet.

Castings weighing about 30 pounds each are now being turned out in large numbers. These, in general, replace sand castings weighing about 25 per cent more.. An iron sand casting of the same volume would weigh close to 100 pounds and would be only about 30 per cent stronger. Aluminum die castings, therefore, will solve many manufacturing problems and their obvious advantages assure their adoption in many lines of industry.

Receivers have been appointed for the Laidlaw-Dunn-Gordon Co., a subsidiary of the International Steam Pump Co., with plant at Cincinnati, O. The property of the company however, will be kept intact.

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Trade Outlook

DURING the month which has just come to a close, foundry operations throughout the United States and Canada were at the low ebb for the year, and the melt, it is estimated, did not exceed 45 per cent of the capacity. In Canada, trade conditions are even more unsatisfactory than in this country, the war having precipitated a business crisis which was threatened for several years following an era of unparalleled prosperity. Specialty shops in the United States, dependent largely upon the automobile trade, report practically no decline in the requirements of motor vehicle manufacturers, and the output, measured solely by present operations, will be as great as in former years. The warm weather which has prevailed during the last 30 days has curtailed the usual, seasonable fill-in trade in the stove industry, and these shops report only a limited output. However, during the last two weeks the machinery plants have received considerable tonnage from machine tool builders to fill rush orders for equipment to be shipped to the arsenals of the belligerent nations. The demand for lathes for shipment abroad has been heavy and the machine tool industry is more optimistic over the outlook than at any time in several years. During the last week of October steel works operations declined to 40 per cent of capacity and prices of pig iron and steel products were marked off to new low levels for the year. The most promising feature of the situation, however, is the improvement noted in the financial condition, and with constantly increasing exports the demand for gold to meet our foreign obligations will be largely relieved. The establishment of the Federal Reserve Banks is another feature that will ease the general financial stringency and with an expansion of loans, business will improve. The shock of the European war already has been absorbed in this country and a return to more normal trade conditions is anticipated in the immediate future. To meet the daily needs of this constantly growing nation entails a far greater consumption than is reflected by manufacturing operations today, and when buying is resumed it will be on a much expanded scale to take up the slack occasioned by the hand-to-mouth policy which has prevailed throughout this year. Railroad buying is at the lowest point recorded in many years and emergency repairs only are being made to rolling stock. The resumption of this demand is dependent almost entirely upon an improved bond market and increased freight rates. The sale of securities has shown some improvement and decisions are anticipated shortly in several of the freight rate cases that have been heard recently by the Interstate Commerce Commission. Pig iron prices have again declined, and in the leading centers, foundry grades are quoted as follows: No. 2, Chicago, $13; Buffalo, $12 to $12.25; Philadelphia, $14.50; Birmingham, $10, and Ironton, O., $13. Malleable is quoted at $13, Chicago, and $12, Buffalo, while basic is held at $14 eastern Pennsylvania, and $13.65, Pittsburgh.

Elevated Crucible Furnace

The accompanying illustrations show a crucible furnace of original design for melting non-ferrous metals, recently placed on the market by the Koons Furnace Co., Anderson, Ind. Fig. 1 shows the crucible in place and

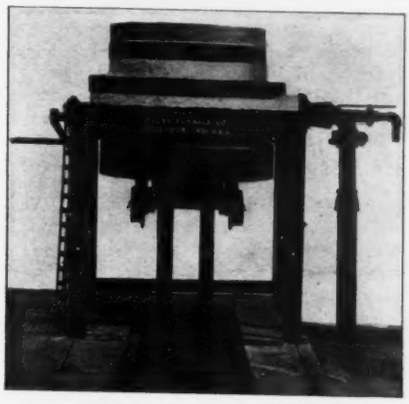


FIG. 1—ELEVATED CRUCIBLE FURNACE IN MELTING POSITION

the furnace ready for use. The fire box or heating chamber is elevated above the floor line and consists of two courses of fire brick resting on a cast iron base. The lower part of the furnace, which carries the hoisting arrangement, is made of angle iron, riveted firmly in place. The crucible and stool are carried by a 4-wheel truck which when lowered rests on a narrow gage track as shown in the illustration. The space between the brick and the outside shell of the carriage is filled with ordinary fine sand, which engages a

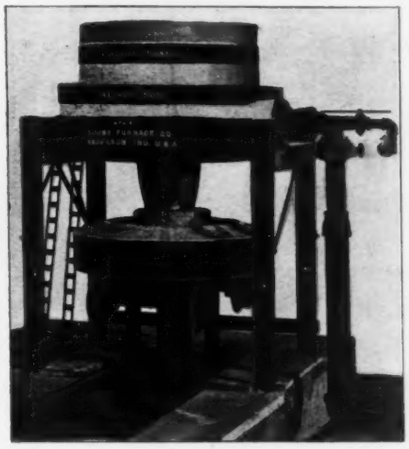


FIG. 2—THE CRUCIBLE RESTS ON A SMALL TRUCK WHICH CAN BE DRAWN OUT FROM UNDER THE FURNACE

cast iron ring on the base of the furnace and makes a fire joint when the crucible is in position for heating.

After the metal is properly melted, the operator lowers the carriage and crucible from the position shown in Fig. 1 until the wheels of the truck rest on the track. He then reaches in with a hook and pulls the truck forward to the position shown in Fig. 2. The crucible is now entirely removed from the furnace and is in a convenient position to be picked up and carried to the pouring floor, either by the molders or by an overhead crane. As soon as the pot of molten metal is lifted from the carriage, another one may be placed in position and another heat begun without loss of time.

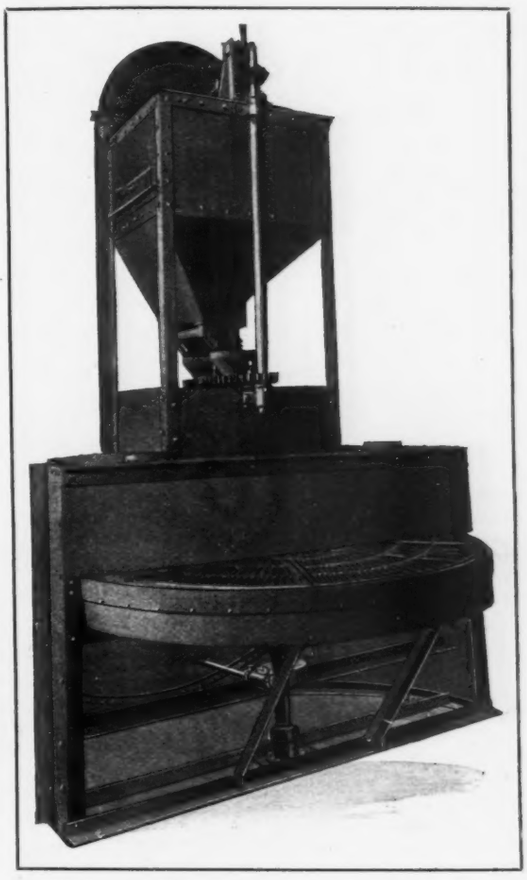
Sulky Sand Riddler

The J. S. McCormick Co., Pittsburgh, now is offering to the foundry trade a sulky sand riddler adapted to riddling all kinds of sand used in foundry operations. Being mounted on wheels, this device can be moved to any portion of the foundry floor and it can be utilized to prepare the heaps for the various foundry floors. The machine is operated by a motor, either direct or alternating current. The device is well balanced and can be moved easily. The wheels are of large size, making it possible to move the machine over irregular floors and sand piles.

Automatic Sand Blast Machine

The superior finish of sand blasted castings has long been recognized, but in many cases this process has not been used for cleaning small castings of irregular shape owing to the large number of pieces to be handled and the great amount involved in blasting by hand. These conditions have led to the introduction of automatic machines specially adapted for sand-blasting small castings. A particularly adaptable machine of this character recently has been developed by the W. W. Sly Mfg. Co., Cleveland. As shown in the accompanying illustration, it consists of a rotating table, half of which is constantly enclosed in a chamber provided with sand blast nozzles connected to a feed hopper.

This machine is built in five sizes, the table diameters ranging from 6 to 12 feet. The smaller sizes have two and the larger machines four nozzles. The table rotates slowly so that the portion that is exposed may be easily loaded and unloaded. The castings near the center of the table pass under the nozzles slower than those which are near the edge, but it is claimed that the nozzle movements are so arranged that the whole surface of the table is sand-blasted thoroughly and uniformly. The machine works on the gravity system, and is connected to a Sly dust arrester which removes flying particles of sand and dirt. A split rubber curtain which is placed across the front of the machine protects the operator from dust and at the same time allows the castings to pass by easily. The energy consumed in driving the table is said to be negligible, varying from 1 to 2½ horsepower.



SLY ROTATING SAND BLAST TABLE MACHINE

The table is built with heavy cast iron arms held in place by a forged steel ring. The grates are made in sections so that they may be easily removed and have sufficient openings to allow the sand to fall through freely. The sand hopper is cast iron and the nozzles are driven by gearing connected to the main drive.

The used sand falls through the gratings of the table into a steel hopper from which it drops into the boot of a bucket elevator that returns it to the feed hopper.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Kelsay Hame Co., Evansville Ind., is completing the erection of a foundry.

The Milwaukee Steel Foundry Co., Milwaukee, will erect a plant, 16 x 138 feet, at a cost of $10,000.

The Oklahoma Iron Works, Bartlesville, Okla., will enlarge and improve the iron foundry which it recently purchased.

The International Foundry, Cleveland, is erecting a brick and steel foundry building, 80 x 150 feet, at 6601 Morgan avenue.

The Hamilton Foundry Co., Norwalk, O., has completed the erection of a new plant to replace the shop damaged by fire last June.

The Delaware Foundry & Machine Co., Delaware, O., is erecting a foundry and will be in the market for foundry equipment.

The E. R. Caldwell & Son Brass Co, Syracuse, N. Y., is erecting a foundry and machine shop.

E. E. Brown & Co., Philadelphia, have purchased a foundry; 64 x 186 feet, located on the southeast corner of Vandalia and McKean streets.

C. A. Blackwelder has purchased a controlling interest in the Concord Foundry & Machine Co., Concord, N. C., from the estate of the late W. R. Johnson.

The Pierce, Butler & Pierce Mfg. Co., Millbrook, N. Y., has been incorporated with $2,350,000 capital to take over the business of the Pierce, Butler & Pierce Mfg. Co., which recently went into bankruptcy.

Heíner & Maysilles, founders and machinists, Grafton, W. Va., are inquiring for complete equipment for a brass foundry, as well as a number of tools for their pattern shop.

The Stanley & Clemens Foundry Co. has been established at Grand Rapids, Mich., and will engage in the manufacture of brass castings.

The Patterson Specialty Foundry Co., Warren, O. has been incorporated with $100,000 capital by F. J. Patterson, J. F. Williams, Frank Croissant, W. A. Megg and L. R. Zinger.

The Alloy Metal Foundry Co., Belleville, Ill., has been incorporated with a capital stock of $2,500 by W. G. E. Rolaff, Henry Reis, Hubert Hartmann Jr. and Ernest E. Wangelin.

The firm name of the Manhattan Specialty Co., 612 East Eighty-third street, New York City, manufacturer of brass and bronze castings, has been changed to the Brass & Bronze Specialty Co.

The International Importing Corporation, Baltimore, is planning to establish a plant in that city for the manufacture of core oil for foundries. The company formerly imported core oil from German manufacturers, but finds its source of supply has been closed.

The firm name of the Crane Valve Co., Bridgeport, Conn., has been changed to the Crane Co., with main offices at Chicago. Richard T. Crane, Third street, Chicago, is president of the company and Charles V. Barrington is secretary. The company now is building an addition to its plant at Bridgeport and other extensive additions and improvements will be made.

New Construction

The Henry Roos Foundry Co., 1749 Ballou street, Chicago, is building a two-story addition 102 x 130 feet.

Richard P. Power, Worcester, Mass., has purchased a site on Albany street, on which he contemplates the erection of a foundry.

The Meadville Malleable Iron Co., Meadville, Pa., will erect an annealing house, 90 x 320 feet.

The Titanium Alloys Mfg. Co., Niagara Falls, N. Y., is erecting a 46 x 60-foot addition to its brass foundry.

The Russell Foundry & Machine Co., 51 Sixth street, Long Island City, N. Y., is building a four-story addition to its plant.

The Verona Steel Castings Co., Verona, Pa., is erecting an addition to its plant which will practically double its output.

The Taber Pump Co., Buffalo, N. Y., will erect a foundry, 117 x 145 feet, and a machine shop, two stories high, 38 x 95 feet.

The Darling Pump Co., Williamsport, Pa., is erecting a new foundry, the steel work for which already is on the ground.

The Spring City Foundry Co., Waukesha, Wis., plans to double the capacity of its plant and will erect a one-story addition, 60 x 112 feet.

The Reading-Bayonne Steel Casting Co., Reading, Pa., will erect a new cleaning room, 26 x 140 feet, and a warehouse, 34 x 135 feet.

Bids are being taken by F. D. Chase, architect, 122 South Michigan avenue, Chicago, for the erection of a foundry, 80 x 150 feet, for the Vermillion Malleable Iron Co., Hoopeston, Ill. The plant will be of brick and steel construction and will cost approximately $40,000.

George M. Harris, of the firm of Terry & Harris, Portland, Ore., contemplates the erection of a cast iron pipe foundry in Portland.

Rumsey & Co., Ltd., Seneca Falls, N. Y., manufacturers of pumps and fire engines, will greatly increase the capacity of their plant by the addition of six buildings.

O. E. Neintz, of the Pacific Iron Works, Portland, Ore., will erect an iron foundry, costing $10,000, and a machine shop, to cost $7,500, at East Twenty-ninth and Halsey streets.

The Pacific Iron Works, Portland, Ore., will erect a foundry and machine shop 60 x 320 feet, a pattern shop, 50 x 100 feet, and a structural steel shop, 62 x 520 feet. A large amount of equipment will be purchased.

Pettibone, Milliken & Co., Chicago, will erect a foundry, pattern shop and pattern storage of fireproof construction. The foundry will be 300 x 500 feet, 50 feet high; the pattern shop, 100 x 200 feet and the pattern storage, 100 x 120 feet. The installation of an electric furnace is contemplated.

The Adamson Machine Co., Akron, O., is building an addition to its iron foundry 160 feet long and 80 feet wide. The building is of concrete, steel and brick construction and will be equipped throughout with modern appliances. This addition will increase the length of the foundry to 320 feet and the daily capacity, when this extension is made, will be 30 tons. The approximate cost of the building will be $25,000.

NEW TRADE PUBLICATIONS

OVERHEAD TRAMRAIL EQUIPMENT.—A 12-page bulletin issued by the Whiting Foundry Equipment Co., Harvey, Ill., is devoted to its line of overhead tramrail equipment for foundry use. The trolleys, hangers, clamps, switches, turntables, etc. are shown in detail and several installation views also are included.

LIGHTING AND VENTILATING DEVICES.—A handsomely illustrated and well-arranged 84-page catalog has been issued by the David Lupton's Sons Co., Philadelphia, which is devoted to the products manufactured by this company for lighting and ventilating industrial plants, warehouses, etc. Numerous illustrations are included showing various buildings containing this type of steel sash for partitions. The Pond sash operating device also is illustrated, as well as methods of constructing skylights, etc.

MONORAIL CRANES.—An exceedingly well-illustrated catalog devoted to electric monorail cranes, has been issued by the Sprague Electric Works of the General Electric Co., West Thirty-fourth street, New York City. These cranes are adapted for a variety of uses in handing material in industrial plants and are particularly applicable to foundry operations. Another catalog recently issued is devoted to dynamometers for measuring horsepower, generated or absorbed. It can be used for testing gasoline engines, carburetors, magnetos, belts, transmissions, etc.

PNEUMATIC TOOLS AND HOIST.—The Ingersoll-Rand Co., New York City, is sending to the trade three bulletins devoted respectively to chipping hammers, drills and a hoist which can be used to advantage for practically all lifting operations in industrial plants. The chipping hammers are of the pneumatic type and can be used for chipping, calking and scaling, while the drills have a variety of uses and applications in industrial plants. The hoist can be used for lifting ashes and other material from basements of buildings and in foundry work where the lift exceeds 20 feet.